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Soil Survey

The Santa Cruz Area California

By

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United States Department of Agriculture

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SOIL SURVEY OF THE SANTA CRUZ AREA, CALIFORNIA

By R. EARL STORIE, in Charge, RALPH C. COLE, BRUCE C. OWEN, and L. F. KOEHLER, University of California, and A. C. ANDERSON, W. J. LEIGHTY, AND JOHN L. RETZER, Soil Survey Division,[1] Bureau of Chemistry and Soils, United States Department of Agriculture

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United States Department of Agriculture in cooperation with the University of California Agricultural Experiment Station

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[1] The Soil Survey Division was transferred to the Bureau of Plant Industry July 1, 1939.

INTRODUCTION

The soil survey map and report of the Santa Cruz area, Calif., are intended to convey information concerning the soils, crops, and agriculture of the area to a wide variety of readers.

Farmers, landowners, prospective purchasers, and tenants ordinarily are interested in some particular locality, farm, or field. They need to know what the soil is like on a certain piece of land, what crops are adapted, what yields may be expected, and what fertilization and other soil-management practices are needed for best results. Many people do not wish to read the entire soil survey report, and they need not do so to obtain much of the information essential to their purpose.

A person interested in a particular piece of land should first locate it on the colored soil map accompanying the report. Then, from the color and symbol, he may identify the soil in the legend on the margin of the map. By using the table of contents, he can find the description of the soil type or types. Under each soil type heading is specific information about that particular soil. There is a description of the landscape—lay of the land, drainage, stoniness (if any), vegetation, and other external characteristics—and of the internal or profile characteristics of the soil—its color, depth, texture, structure, and chemical or mineralogical composition. The description also includes information about present land use, crops grown, and yields obtained, and statements concerning possible uses and present and recommended management.

By referring to the section on Ratings of Soils as to Their Suitability for Cropping the reader may compare the soil types as to productivity for the various crops and as to suitability for the growth of crops or for other uses.

For the person unfamiliar with the area, a general description of the area as a whole is included in the first part of the report. Geography, physiography, regional drainage, relief, vegetation, climate, population, transportation facilities, and markets are discussed. A brief summary gives a condensed description of the area and important facts concerning the soils and agriculture.

The agricultural economist and the general student of agriculture will be interested in the sections on Agricultural History and Statistics, Soils, and Ratings of Soils as to Their Suitability for Cropping.

Soil specialists, agronomists, experiment station and agricultural extension workers, and students of soils and crops will be interested in the more general discussion of soils in the section on Soils as well as in the descriptions of the soil types. They also will be interested in the section on Ratings of Soils as to Their Suitability for Cropping.

For the soil scientist, the section on Morphology and Genesis of Soils presents a brief technical discussion of the soils and of the soil-forming processes that have produced them, and laboratory analyses are given in the section on Laboratory Studies.

AREA SURVEYED

The Santa Cruz area lies along the coast of California about 60 miles south of San Francisco and 295 miles north of Los Angeles (fig. 1). It comprises Santa Cruz County, a small area in Monterey County south of the Pajaro River, and about 3 square miles in San Benito County east

of Aromas. The area ranges from 10 to 18 miles in width and is about 40 miles long. It extends from the Pacific Ocean eastward to the crest of the Santa Cruz Mountains. It is bordered on the northwest by San Mateo County, on the east and northeast by Santa Clara County, and on the south by an arbitrary line drawn diagonally from the mouth of the Pajaro River eastward to a point about 2 miles southeast of Aromas. The southern boundary of the area joins with the northern boundary of the Salinas area surveyed in 1925 (*4*).[2] The part in San Benito

FIGURE 1.—Sketch map showing location of the Santa Cruz area, Calif.

County is bordered on the south by the Hollister area (*5*). The northwestern part, or that part situated north and west of Santa Cruz, was covered by the reconnaissance soil survey of the San Francisco Bay region made in 1914 (*6*). The southeastern part, the Pajaro Valley, was covered by an earlier soil survey of the Pajaro Valley made in 1908 (*8*).[3] The Santa Cruz area comprises a total of 456 square miles, or 291,840 acres. Of this, 435 square miles includes Santa Cruz County, about 18 square miles is in Monterey County, and about 3 square miles is in San Benito County.

Physiographically, the area may be divided into five divisions: (1) Hilly and mountainous upland areas; (2) rolling to hilly and eroded

[2] Italic numbers in parentheses refer to Literature Cited, p. 90.

[3] Many changes from the soil names given in the older soil surveys may be noted. These changes are due to much greater detail in mapping this area, data accumulated throughout years of field study and development in the science of soil classification since the dates of the earlier surveys, which were mainly of broader reconnaissance character. The more important changes are mentioned in the text.

coastal-plain areas; (3) alluvial fans and stream bottoms; (4) coastal-plain areas (modified by wind); and (5) smooth valley and coastal-terrace areas.

Hilly and mountainous upland areas represent about 69 percent of the area surveyed, including the Santa Cruz Mountains, which extend from the Santa Clara County line along the northeastern side of the

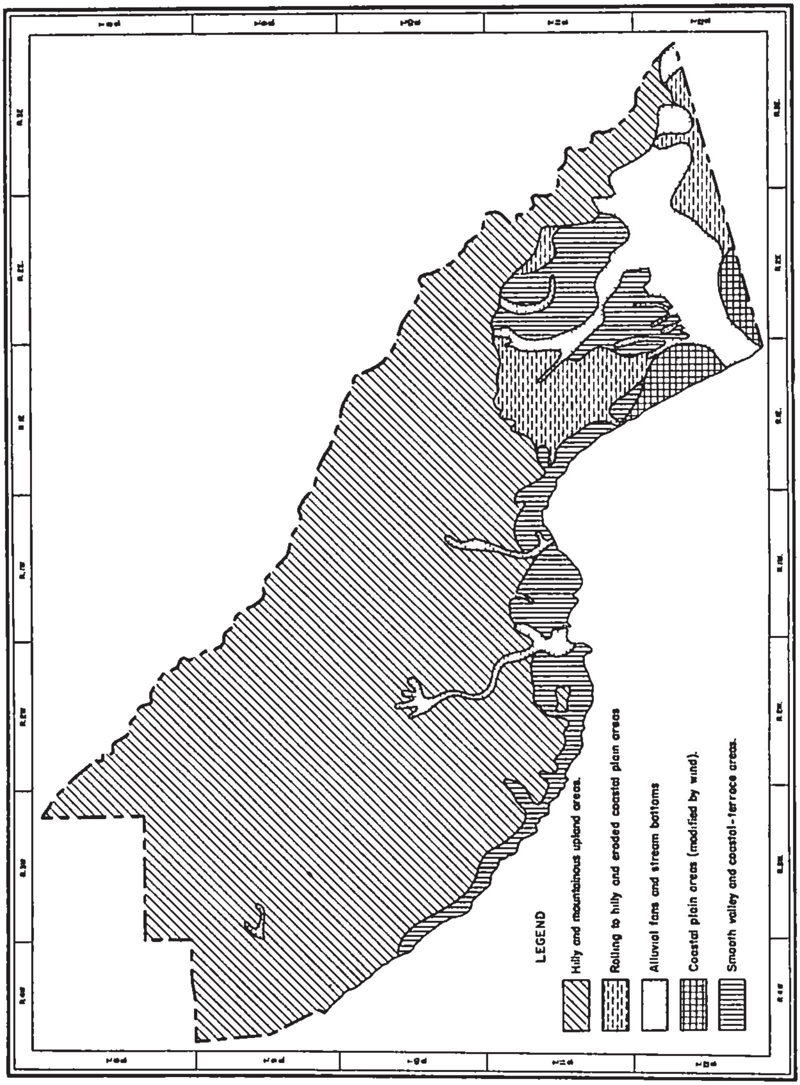
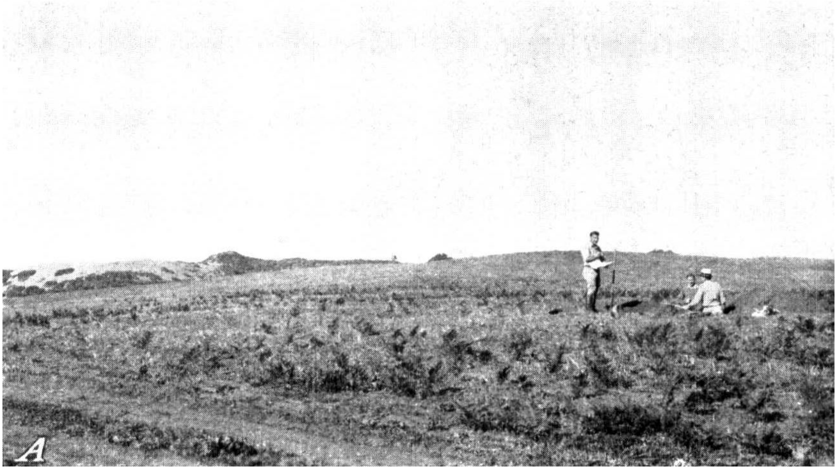


FIGURE 2.—Major physiographic divisions of the Santa Cruz area, Calif.

area to the Pacific Ocean in the northwestern part and which narrow in the southeastern corner of the area to a width of about 2 or 3 miles (fig. 2). The crest of the Santa Cruz Mountains forms the county line between Santa Cruz and Santa Clara Counties. The elevations of this mountain crest range from 1,200 to 3,000 feet above sea level. Geologically, this upland belt is composed primarily of sedimentary rocks,

A. Soils of the Hugo series, showing hilly relief. Some of the steeper areas have been planted to grapes, but yields generally are low and erosion is active. *B*. Small clearing in redwood forest near Big Basin. Cost of removing the large stumps prevents extensive clearing.



A Marina sand developed on wind-modified sandy coastal terraces Note characteristic smooth undulating relief Area of dune sand in distance on left.
B, Coastal terrace with wave-cut cliff near Santa Cruz

such as sandstone and shale. The Monterey shale (*2*) is fairly hard, whereas some of the other sandstones and shales are comparatively soft. One area composed of igneous rocks is west of Ben Lomond and Boulder Creek. The relief of the uplands is steeply rolling to mountainous (pl. 1, *A*), and the soils included are those of the Hugo, Cayucos, Santa Lucia, Sheridan, Holland, Felton, and Arnold series.

Originally much of this land had a native cover of trees or, on the shallower soils, brush. The forest growth consists of redwood, Douglas-fir, California buckeye, madrone, coast live oak, and Oregon myrtle (California laurel). Most of the brush-covered areas on the shallower soils have a native cover of fourwing saltbush (chamiso), manzanita, bracken, and poison-oak. Many of the areas that support a stand of commercial timber are in the mountain basins, such as Big Basin (pl. 1, *B*) and Little Basin, which are in the northwestern part of the county, on the northern slopes, or in basins, where considerable moisture is available. Most of the soils on which laurel, oak, and other brush and shrubs grow are on the crests of the ridges. Some ponderosa pine (western yellow pine) grows on the light-colored sandy-textured soils. Many of the ridges west of Felton and in the northwestern part of the area, where the surface soil is very thin, have a cover of fourwing saltbush. Very few of the latter areas support any trees sufficiently large for use as timber, with the possible exception of small second-growth pine.

An upland coastal-plain area of undulating hills lies midway between Santa Cruz and Watsonville and extends from San Andres School northward to a point about 1 mile north of Corralitos. Much of this land has a native cover of coast live oak and brush. It is occupied by soils of the Tierra and Moro Cojo series and erodes very badly.

The largest area of alluvial valley borders the Pajaro River in the southeastern part of the area. The Pajaro Valley ranges from 2 to 4 miles in width and extends westward from Chittenden, the point where the river enters the area, through a pass in the Santa Cruz Mountains, to the coast. Other alluvial valleys are those in which Browns Creek and Corralitos are situated. These latter valleys are narrow, probably averaging less than a half mile in width. Small alluvial valleys border Soquel, Aptos, Waddell, and Scott Creeks. With the exception of the Pajaro Valley, the area of alluvial valley bottom land is not very large. Originally this valley land had a native cover of redwood and other trees, but, since many of the trees have been removed, grass has taken their place where the land is not farmed. In many places the soils of these valleys or bottom lands are very wet and poorly drained and support a native cover of water-loving grasses.

A strip of wind-modified sloping or undulating coastal plain, about 1 or 2 miles wide, lies directly west of Watsonville. Immediately bordering the coast the sandy material of the coastal plain is subject to wind action but becomes more stable as it extends eastward and inland. This sandy coastal plain formerly had a native cover of low brush and grasses, but much of the land has been cleared and cultivated, with the possible exception of the sand-dune areas immediately bordering the ocean (pl. 2, *A*).

A belt of old alluvial or marine terraces begins north of Davenport

and extends southward along the coast to a point about 3 miles south of Aptos. This terrace belt is very narrow at Davenport and widens to about a mile at Santa Cruz (pl. 2, *B*). A similar terrace area is north of Watsonville in the vicinity of Freedom and extends inland toward Carlton School. In the vicinity of Watsonville these terraces comprise approximately 9 or 10 square miles. They support a grass cover mainly, with a few oaks and other trees along the slopes. The surface of these terraces, most of which slope gently toward the ocean, is comparatively smooth.

Santa Cruz County is drained by a number of streams that have their sources within the county. These include Waddell, Scott, and Big Creeks and the San Lorenzo River, in the northern part, and Soquel, Aptos, Trout, Valencia, and Corralitos Creeks in the central part. The gradient of these streams is very steep in the mountainous part of the county. The Pajaro River, which traverses the extreme southeastern part through the Pajaro Valley, has its source in San Benito County. The streams that head in the Santa Cruz Mountains usually carry water throughout the year, whereas the Pajaro River does not carry water during the summer, partly because it heads in an area of low rainfall and partly because water is taken out for irrigation farther up the stream.

The Santa Cruz area is well supplied with railroads, highways, and modern conveniences. The coast line of the Southern Pacific Co., operating from San Francisco to Los Angeles, enters the southeastern part of the area near Aromas and passes through Watsonville Junction and thence south. A branch line at Watsonville Junction gives connection with Watsonville, Aptos, Capitola, and Santa Cruz; another branch extends from San Jose through Los Gatos and over the Santa Cruz Mountains to Santa Cruz, and a third extends northward along the coast from Santa Cruz to Davenport. Points in the northern part of the area are somewhat remote from railroad transportation, but the quantity of produce that is shipped from there is comparatively small.

Numerous paved highways throughout the area lead to outside points. Paved highways extend northward from Santa Cruz through Davenport to San Francisco along the coast and from Santa Cruz to Los Gatos and San Jose. In the southern part paved highways extend from Watsonville over Hecker Pass into the Santa Clara Valley. Highways extend from Watsonville up the Pajaro River into San Benito County, and southward from Watsonville to Castroville and Salinas in Monterey County. The agricultural areas are well provided with paved roads. The mountainous districts have roads extending to summer resorts, with secondary roads to isolated farms. The county roads are usually in good condition, so that little difficulty is experienced in getting over the entire area. Telephones, electric lights, and gas are available to many of the agricultural districts and to the mountain districts that have a large summer tourist trade.

Farm produce from the Santa Cruz area is shipped to a large number of markets. Lettuce, which is an important crop at present, is chiefly shipped to eastern markets, only a small percentage being consumed in California. Artichokes and brussels sprouts are shipped to a large number of markets, both in California and in the eastern part of the United States. Apples, which have been an important

crop in this area for a long time, are shipped primarily to the Los Angeles market, although some sales are made in San Francisco and other points along the coast. The Yellow Newtown is shipped chiefly in trucks; the Yellow Bellflower is marketed directly from the orchard or placed in cold storage and distributed later. Fresh cherries are shipped chiefly to Los Angeles. Apricots are sent to canneries in San Jose or are shipped as dried fruit. Tomatoes are usually taken to the canneries in San Jose. Most of the strawberries and bush berries are marketed in San Francisco and Los Angeles, although some are sold in nearby local towns. San Francisco is the principal market for eggs and poultry. Most of the vegetable crops are marketed locally, particularly during the summer tourist season, when there are thousands of vacationists in the mountainous part of the area. Dairy products, which are of minor importance, are usually marketed locally in the form of fresh milk. During the summer milk products are usually insufficient to supply the local demand, whereas during the remaining 9 months milk products are exported.

The sections near the present sites of Santa Cruz and Watsonville were first explored by Portola and his expedition in the year 1769.[4] Near the present site of Watsonville, redwood was first discovered and described by Father Crespi and was called redwood because of the color of the bark and wood. The first settlers came with the founding of the Santa Cruz Mission in September 1791. The mission was destroyed in January 1857, but was restored in 1930. In 1797 the Villa of Branciforte was established on the south side of the San Lorenzo River. In 1833 the first grant of Spanish ranchos was made in the area. The county of Santa Cruz was organized in 1850, with Santa Cruz as the county seat. The population at the time the county was formed was stated to be 643, most of whom were living in and about the mission at Santa Cruz. A few people migrated south to the Pajaro Valley in 1852.

The United States census for 1940 gave the population of Santa Cruz County as 45,057, of whom 82.6 percent are native white, 12.6 percent are foreign-born white, and 4.8 percent are of other races, mainly Chinese. Of the total population, 42.7 percent is classed as rural and 57.3 percent as urban, and of the rural population 39 percent is classed as farm population and 61 percent as nonfarm. Santa Cruz is the largest city, having 16,836 inhabitants in 1940, and Watsonville had a population of 8,937 in the same year. Other towns in the area, having a very small population, are Aromas, situated in the upper end of the Pajaro Valley; Corralitos, situated about 7 miles north of Watsonville; Aptos, situated about 8 miles east of Santa Cruz; and Davenport, situated along the coast about 10 miles northwest of Santa Cruz. A number of summer-resort towns, which owe a considerable part of their population to summer vacationists, include Brookdale, Ben Lomond, Felton, and Boulder Creek in the Santa Cruz Mountains north of Santa Cruz; and beach-resort towns, in addition to Santa Cruz, are Capitola and small towns to the southeast. The summer residences are concentrated mainly in the San Lorenzo Valley, in the valleys of tributaries and creeks, and along the coast between Santa Cruz and Aptos.

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[4] Information on the history of this area was obtained from Bancroft (*1*), Martin (*9*), Torchiana (*18*), and from the following paper: PARRISH, NARCISSA L. THE EARLY HISTORY OF THE SANTA CRUZ REGION. Calif. Univ. M. A. thesis. 1925. [Typewritten.]

CLIMATE

The climate of the Santa Cruz area is similar to that of other areas along the California coast south of San Francisco. The Pajaro Valley in the southern part of Santa Cruz County, the largest valley in the county, has a climate similar to that of the Salinas Valley to the south and other coastal valleys. The area is characterized by two seasons, the dry or summer season, extending from May to October, and the wet or winter season, comprising the other months. More than one-half of the rain falls during December, January, and February. The amount of precipitation varies widely from place to place. The rainfall is lowest along the coast; it becomes heavier toward the mountains. This is clearly shown by following a line from Santa Cruz north through Felton, Ben Lomond, and Boulder Creek. At Santa Cruz the mean annual rainfall is 26.13 inches, at Felton 47.36, at Ben Lomond 55.91, and at Boulder Creek 55.57. The increase in precipitation from Santa Cruz to Felton, a distance of approximately 7 miles, is large; from Felton to Ben Lomond the increase is noticeable; but the difference between the precipitation at Ben Lomond and at Boulder Creek is very small.

During the rainy season the prevailing winds blow from either the north or the south, causing alternate rainy and clear weather; but during the summer they generally blow from the west or northwest, coming over the Pacific Ocean with great regularity, rising in the forenoon and subsiding in the evening. They gather moisture from the Pacific Ocean, forming fogs during the night. These fogs, which occur in the Pajaro Valley and along the coast to the northern edge of the county, usually disappear about the middle of the following day but frequently continue throughout the day. They are of great benefit to the farmers, as they retard evaporation of soil moisture and transpiration of plants, especially in the district northwest of Santa Cruz, where artichokes and brussels sprouts are produced. Without the summer fogs these crops could not be produced profitably. During the rainy winter season fogs are infrequent. In the mountainous areas fogs penetrate into the canyons, especially along Soquel Creek and the San Lorenzo River as far north as Boulder Creek. Fogs occur sometimes in the Big Basin section but usually disappear in the late forenoon.

Killing frosts may occur from November to March. Frosts have occurred as late as May 26 and as early as September 25 at Watsonville. The average frost-free season is 237 days at Watsonville; and at Laurel, which is well protected from wind and frost, it is 289 days. Temperatures are too severe for the commercial growing of subtropical or the more sensitive fruits, but in a few well-protected spots in the mountains a few lemons for home use are grown.

Table 1 gives the normal monthly, seasonal, and annual temperature and precipitation at Watsonville, Santa Cruz County, Calif.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Watsonville, Santa Cruz County, Calif.*

[Elevation, 23 feet]

Month	Temperature			Precipitation		
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1917)	Total amount for the wettest year (1909)
	°F	°F.	°F.	*Inches*	*Inches*	*Inches*
December	50 2	82	15	5 56	0.32	10 41
January	50 2	80	20	5 58	1.65	14.10
February	52 0	84	23	4.81	5.22	7.39
Winter	50 8	84	15	15 95	7.19	31.90
March	54 2	95	24	4.25	.87	4.12
April	56 2	90	22	1 73	.28	.00
May	58 6	96	26	85	10	.00
Spring	56 3	96	22	6.83	1 25	4.12
June	61.0	110	31	.13	.00	.10
July	61 6	105	32	.01	.00	.00
August	61 7	95	30	.01	.00	.00
Summer	61 4	110	30	15	.00	.10
September	60 9	105	32	.44	.00	.44
October	58 4	104	22	1 17	.00	.79
November	54 3	90	23	2.63	.84	1.80
Fall	57.9	105	22	4.24	.84	3 03
Year	56 6	110	15	27.17	9.28	39.15

AGRICULTURAL HISTORY AND STATISTICS

The first agriculture carried on in Santa Cruz County was that surrounding the mission at Santa Cruz. The field crops—wheat, corn, and barley—were the principal crops grown, and surrounding the mission was a 10-acre fruit orchard consisting mainly of pear and olive trees and a few grapevines. No data are available as to the exact date of planting, but the orchard probably was set out in 1792 or 1793, as the mission itself was founded in 1791. The raising of livestock was important, and by 1800 the mission was exporting breadstuff, hemp, cordage, hides, and tallow. The population and the agricultural expansion around the mission showed slow but rather steady increase. In 1814 an inventory of the lands of the mission revealed that they included 11 leagues (1 league is approximately 2.63 miles) along the coast and 3 leagues inland from the shore. This extended from Point Año Nuevo south to Aptos or slightly beyond. In 1817 the crops were almost completely destroyed by rust.

In 1833 the first grants of ranchos were made by the Mexican Government in what is now Santa Cruz County. In 1834 the Santa Cruz mission was secularized, most of the assets of the mission were destroyed by squander and neglect, and the Indian converts soon dissipated what substance they were given from the mission.

California was acquired by the United States in 1846, and the Government recognized all Mexican land grants made previous to this time. In November 1851 the first settlers entered the Pajaro

Valley for the purpose of farming. Although several houses were already in the valley, they were used only by herdsmen on the cattle ranchos. The soil of the Pajaro Valley was exceedingly fertile, so that in 1853, when the exodus of people from the mining counties to the so-called "cow counties" began, considerable difficulty with squatters on the rancho grants in the Pajaro Valley resulted.

One thousand acres of the Salsipuedes Rancho was rented by an American named J. B. Hill, who planted 200 acres to potatoes and obtained a large yield, which he sold at 15 cents a pound. These large yields soon caused all the alluvial bottom lands to be planted to potatoes and grain. (Mr. Hill is said to have brought the first iron plow into the county.)

The first planting of apples by Americans was made at Sequel in 1847–48, the varieties being Virginia Greening, Baldwin, and Rhode Island Greening. The first successful apple orchard was planted in 1852 or 1853, and the first commercial orchard was planted in 1858. The first strawberries were grown for market in 1860 and were sold for $2 a quart. Logan blackberries (Loganberries) and Mammoth blackberries were originated by J. H. Logan in Santa Cruz and introduced in 1893.

The coming of the railroad into the Pajaro Valley in 1870 stimulated agriculture because of the increased market made available. Commercial fruit growing became important about 1880; most of the plantings prior to that time were for home use. A beet-sugar factory built near Watsonville in 1886 was soon abandoned, and sugar beets from the Pajaro Valley were shipped to Salinas on a narrow-gage railroad.

Tables 2 and 3 give the number and size of farms, population, and acreages of the principal crops of Santa Cruz County, as reported by the census for the years 1880 to 1940, inclusive. These data show the trend of agricultural development.

TABLE 2.—*Number and size of farms, and population of Santa Cruz County, Calif., as reported by the census, in stated years*

Year	Rural population	Farms	
		Number	Average size
			Acres
1880	8,904	584	189 1
1890	13,674	916	137 6
1900	12,325	1,274	125 9
1910	10,548	1,466	107.3
1920	10,339	1,759	82 3
1930	14,694	1,855	67 1
1940	19,224	1,712	61 4

In 1940 the census reported 1,712 farms in the county, having an average size of 61.4 acres. In the early days the farms were large, but the average size has continually decreased. In 1890 the average size was reported to be 137.6 acres, or about twice what it was in 1940. Owners operated 1,191 farms, part owners 134 farms, managers 18 farms, and tenants 369 farms in 1940. In that year land in farms included 105,059 acres, or 37.4 percent of the total area of the county. Of this, 37,388 acres was classed as cropland and 20,897 acres as plowable pasture. A total of 58,285 acres, or 20.7 percent of the total area

of the county, was classed as tillable land. State forestry officials state that about 70 percent of the county has a forest or brush cover.

TABLE 3.—*Acreage of principal crops in Santa Cruz County, Calif., as reported by the census, in stated years*

Crop	1879	1889	1899	1909	1919	1929	1940
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Corn	1,768	2,752	4,287	1,136	2,463	456	439
Oats	934	2,557	6,924	2,282	1,082	883	223
Dry beans	-------	-------	645	577	1,644	2,603	1,664
Potatoes	-------	708	1,007	1,080	875	388	170
Market vegetables	-------	-------	584	648	651	6,031	9,389
Sugar beets	-------	-------	2,759	312	513	-------	1,399
All hay	6,540	12,443	19,660	17,348	13,056	6,113	4,634
Alfalfa	-------	-------	155	255	616	333	243
Small grains cut green	-------	-------	15,888	16,609	12,144	5,487	3,948
Berries (bush)	-------	-------	135	255	[1] 907	317	356
Strawberries	-------	-------	520	489	-------	298	422
	Vines	*Vines*	*Vines*	*Vines*	*Vines*	*Vines*	*Vines*
Grapes [2]	-------	-------	1,385,442	1,365,414	629,816	700,893	554,491
	Trees	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*
Apples [2]	-------	109,828	557,361	647,136	665,535	593,178	529,944
Peaches [2]	-------	29,250	38,210	11,868	15,486	8,586	6,539
Apricots [2]	-------	12,130	62,879	63,021	77,749	106,259	51,817
Pears [2]	-------	10,735	31,466	23,100	27,450	64,149	88,371
Plums and prunes [2]	-------	58,501	289,831	112,269	103,154	125,775	98,039
Cherries [2]	-------	8,199	27,901	17,608	-------	30,583	29,989
Walnuts [2]	-------	-------	4,907	4,015	2,671	2,863	2,676

[1] All small fruits.
[2] Trees and grapevines are for the years 1890, 1900, 1930, and 1940, respectively.

In recent years a gradual change to the more intensive types of agriculture has taken place. During the early years agriculture consisted of growing grain, grain hay, and potatoes. Apples and sugar beets soon replaced grain in importance on the soils of the Pajaro Valley. The acreage of most of the field crops, such as corn and oats, has diminished considerably over that reported in 1890 or 1900. The chief changes have been the increase in the production of lettuce in the Pajaro Valley, of vegetables on the smaller farms over the area, and of artichokes and brussels sprouts along the coast north of Santa Cruz. The type of farming in the mountainous districts has changed very little, except possibly the acreage of grapes and tree fruits has been slightly reduced as the vines and trees deteriorated from old age.

The 1940 census reports an expenditure of $572,130 for feed, grain, and hay in Santa Cruz County, and an expenditure of $107,485 for fertilizer.

Up until the time that farmers in the Pajaro Valley began to grow lettuce, the production of apples was the largest enterprise in the area; and even today the Pajaro Valley ranks as the largest apple-growing section in the State. Probably about 50 acres were devoted to apple trees in 1860, about 250 acres in 1870, and about 500 acres in 1880, and there was a rapid increase in acreage between 1880 and 1890. The peak acreage in apple trees was reached about 1910, after which the acreage remained fairly constant until about 1928. Probably about 15,000 acres were in apples in 1910 within the territory covered by this survey, but since that time the acreage has been reduced to some extent owing to the expansion of the production of lettuce on the alluvial soils of the valleys. The California Coopera-

tive Crop Reporting Service reported the acreage in apple orchards in Santa Cruz County in 1937 at 10,311 acres. At present it is estimated that the orchards cover about 12,500 acres in Santa Cruz County and that part of the Pajaro Valley in Monterey County included in this survey. The latter section, according to a crop survey made at the same time as the soil survey, included about 1,076 acres in apple orchards.

It is estimated that approximately 2,200,000 boxes of apples are produced annually, with a value of approximately $1,400,000. More than 4,000 tons annually are dried in the Watsonville district. Cider and vinegar are important products in the utilization of apples. Local estimates put the value of apples and total apple products between $2,000,000 and $2,800,000 for the Watsonville district. About 90 percent of the annual production of apples is utilized in California, and a large percentage goes to the Los Angeles market. The Yellow Newtown is the principal variety of apple grown, and the Yellow Bellflower is second in importance. About 60 percent of the present apple acreage consists of Yellow Newtown and about 30 percent of Yellow Bellflower, with the remaining 10 percent of such varieties as White Pearmain, Delicious, Banana, and Jonathan. It is to be noted that the acreage of red apples is not large, both the Yellow Newtown and Yellow Bellflower varieties being so-called white or yellow sorts.

More than 75 percent of the apple acreage is on the bottom lands in the Watsonville-Pajaro Valley district. Nearly all of the shipments go out from Watsonville. Yields of 600 to 1,600 boxes an acre are obtained on the soils of the bottom lands, which are members of the Soquel, Botella, Salinas, Corralitos, and Pajaro series. The largest yields are obtained on the loams, fine sandy loams, silt loams, clay loams, and silty clay loams of these series. Apples on the soils of the terraces and uplands do not produce so heavily. The soils of the Watsonville series are not well adapted to the production of apples, and, although apples have been planted on these soils, yields are low and the loss of trees has been considerable. The Yellow Newtown seems to do better on the shallower soils than the Yellow Bellflower. In general, the Yellow Newtown seems to have more promise than other varieties, chiefly because of the diminishing plantings in other parts of the State and Nation and also because of its good shipping and keeping qualities.

Yields of apples differ considerably, depending on the age of the trees and the soil conditions under which they are planted. It may be safely stated that the good soils of the valleys in the vicinity of Watsonville will produce about 1,000 boxes an acre; members of the Pinto series, which are formed on the terraces, from 400 to 500 boxes under good conditions; the residual soils of the uplands—members of the Hugo and Cayucos series—from 200 to 400 boxes under good conditions; the sandy soils of the Moro Cojo series, between 75 and 250 boxes; and the claypan soils of the Watsonville series, formed on terraces, from 200 to 350 boxes. These yields assume the age of trees to be from 15 to 20 years. Cultural practices in general consist of fairly shallow cultivation on the shallow soils and deeper cultivation on the deeper soils.

Many of the orchardists grow a cover crop of wild mustard or purple vetch. Many of the growers on the recent and young alluvial

soils in the Pajaro Valley have not used fertilizers in their orchards to a great extent, and it has been proved that the application of nitrates has increased the size of apples and in some orchards has increased the yields. Probably fertilization would give greater increases in yields on the soils of the terraces and the sandier soils of the uplands. Some growers on the valley lands apply barnyard manure, and they state that yields are increased, although some tests conducted on the same soils do not show very great increase in yield. It has been only within recent years that the orchards have been irrigated. Probably the need for irrigation on the deeper alluvial soils is slight, although possibly in years of low rainfall irrigations will materially increase the yield as well as keep the trees hardier. Field tests show that the largest increases in yield after an irrigation are on the shallower soils and on the heavier textured soils. During the earlier years of growing apples many orchards were interplanted with strawberries or sugar beets, and such crops require irrigation.

In regard to total income derived therefrom, lettuce is the most important crop now grown within the area (7). In 1935 approximately 3,500 acres were devoted to lettuce in Santa Cruz County in the vicinity of Watsonville and about 3,000 acres in the Pajaro Valley part of Monterey County, making a total of 6,500 acres. The total income to the grower from lettuce (f. o. b.) was reported to be $4,142,280 from a total shipment of 7,692 cars in 1934.[5] This includes estimated carlot shipments by truck as well as those by rail.

The climate and soils of the Pajaro Valley seem very well suited to the production of lettuce, and usually two crops are grown each season. Lettuce can be successfully matured during any time of the year except the rainy season, which occurs between December and March. This crop requires from 75 to 150 days to mature.

Lettuce is grown on the soils of the bottom lands, ranging from fine sandy loams to silty clays of the Salinas, Botella, Metz, and Soquel series. The heavier textured soils produce heavily, but they cannot be managed so easily as the lighter textured soils during rainy weather. The medium-textured soils of the bottom lands that are high in organic matter produce the largest yields as well as the best quality of lettuce. Large quantities of barnyard manure are used for lettuce, and applications of 8 to 12 tons an acre have materially increased or maintained the yields. Green-manure crops, preferably legumes, such as annual yellow sweetclover (*Melilotus indica* (L.) All.) are used by many growers to maintain the organic content of the soil. Readily available nitrogen, in the form of sodium nitrate, ammonium sulfate, calcium nitrate, or ammonia, is often added, in order to produce a good growth and color before the heading period. Two or three crops of lettuce are produced on the same land in a year; therefore it becomes necessary to maintain the soil fertility by the use of crop rotation, manures, cover crops, and inorganic fertilizers.

Lettuce requires a uniform supply of moisture throughout the growing season, and this is supplied by the furrow type of irrigation. The frequency of irrigation depends on soil conditions and the climate. Care should be used in order not to overirrigate, which is frequently done in this district.

Lettuce yields between 150 and 250 crates an acre for each crop.

[5] Estimated by local shippers as reported to the Board of Trade.

Much of the lettuce is grown by large operators who lease the land for that purpose. Lettuce land leases for $40 to $70 an acre a year. Labor for producing and harvesting the crop is contracted for at 25 to 35 cents an hour.

Strawberries and bush berries constitute the third most important crop in the area. During the early years of apple growing, many strawberries were set out between the rows of young trees. The acreage of strawberries has ranged between 500 and 1,000 acres. The 1940 census reports 422 acres in Santa Cruz County and a production of 2,086,433 quarts. The annual return from strawberries in this area is estimated at about $260,000.

In the early days the acreage in strawberries was confined chiefly to the alluvial soils of the Salinas, Botella, Soquel, and Pajaro series in the Pajaro Valley. Within recent years the search for new strawberry land has led to the use of Watsonville loam and Pinto loam on the terraces in the Freedom district. Strawberries are produced for 4 to 6 years, after which the plants die. During the last few years many plants have died sooner, owing to the infestation of verticillium wilt in many soils. In setting out strawberry plants, care should be used to select plants from beds free of wilt and to select land that has not been previously cropped with plants so affected. Tomatoes are known to be responsible for the spread of the wilt fungus, and care should be taken not to plant strawberries on land previously cropped to tomatoes. The Nick Ohmer and Capitola varieties of strawberries appear to be very susceptible to wilt, whereas the Marshall (Banner) and Klondike varieties appear to be comparatively resistant (*12*).

Medium-textured soils are the easiest to manage for strawberries, owing to the frequency of irrigation during the summer. Claypan soils, such as Pinto loam, seem to be well adapted to strawberries, although they have to be fertilized more heavily than the alluvial soils of more recent deposition. Strawberries seem to do better on acid soils than on neutral or alkaline soils. Where the claypan is close to the surface, these soils are not so desirable, because the surface soil becomes saturated after an irrigation. Soils of the Pinto and Watsonville series that are developed on the older terraces need to be fertilized with barnyard manure, chicken manure, and green manures along with a top dressing of commercial fertilizer carrying a high content of available nitrogen.

An acre of berries in full bearing produces from 75 to 125 crates. The cost of producing strawberries is high, owing to the large amount of hand labor required. Most of the strawberries are grown by Japanese. Land for strawberry culture rents for $30 to $70 an acre, which includes a source of irrigation water from wells.

The acreage in bush berries, such as Young dewberries (Youngberries), Logan blackberries (Loganberries), other blackberries, and raspberries, has varied between 300 and 1,000 acres for the county. Owing to the small size and the large number of the individual plantings, it is very difficult to estimate the total acreage. This enterprise is of considerable importance, probably bringing approximately $600,000 in gross returns a year. The plantings of bush berries are scattered along the coastal plain, but the largest numbers of plantings are in the Freedom, Aptos, Soquel, and Capitola districts. Local conditions seem well suited to their culture (*3*). They

do well on a wide range of soils. The soils of the terraces give good results, owing to the air drainage and the smooth surface, which is easily irrigated. Some plantings are grown without irrigation, but it is common practice to irrigate.

Artichokes and brussels sprouts have become important crops in the coastal plain north of Santa Cruz. The California Cooperative Crop Reporting Service reported a planting of 3,000 acres in 1924–25, 3,280 acres in 1925–26, 2,000 acres in 1927–28, and 1,300 acres in 1932–33 in Santa Cruz County (*11*). Commercial plantings are limited to areas that are as near frost free as possible in the winter and that are cool and foggy in the summer. The district north of Santa Cruz along the coast in the fog belt provides these conditions.

The globe artichoke is grown under a fairly wide range of soil conditions. The plant is deep-rooted and does best on the deeper soils, although a considerable acreage is devoted to this crop on soils that have claypan subsoils at a depth of 18 to 30 inches. In many places it is necessary to sacrifice the best soil conditions in order to obtain the right climatic conditions. Considerable acreages of brussels sprouts and artichokes are on Watsonville sandy loam, Watsonville loam, and Lockwood loam. The yield of artichokes ranges from 100 to 150 boxes an acre on the soils of the terraces. Soquel loam produces somewhat better yields but the crop must be harvested before December, as the danger of frost is great in the bottom lands after that time. Acre applications ranging from 5 to 10 tons of manure every other year have given good results. The leaves and stems are usually returned to the soil after harvest. Many growers apply from 300 to 400 pounds of nitrogenous inorganic fertilizer to the acre before the buds begin to form, usually nitrate of soda or ammonium sulfate. Artichokes are usually irrigated about twice a month during the growing season, but care should be used not to overirrigate, as excessive irrigation on the Watsonville soils causes a saturated condition that is injurious to the plants. The quantity of water applied should be only sufficient to wet the soil to the depth of the root zone.

Approximately 2,200 acres are devoted to apricots, 1,260 acres being reported by the California Crop Reporting Service in 1937. In 1930, 1,400 acres produced 4,898 tons of fruit, or approximately 3½ tons to the acre. About 850 acres in apricots are in the Aromas district in Monterey and San Benito Counties. The yields on the Pinto soils northeast of Watsonville are the same as or somewhat higher than the yields reported above, and yields on the Moro Cojo soils in the Aromas district are somewhat lower. The principal varieties grown are the Royal and Blenheim. The fruit is canned and dried. Apricots do not do well close to the coast. They should be planted only on the more sheltered better drained soils on the eastern side of the Pajaro Valley. Most of the apricot orchards are not irrigated. Cultural practices are the same as those followed in other sections of California, and very little fertilizer is used.

The California Crop Reporting Service reported 1,403 acres of bearing plum and prune trees in the county in 1937. These are grown chiefly in the district around Highland School on the crest of the Santa Cruz Mountains. Districts closer to the coast are not well suited to plums and prunes because of the fogs and high humidity. Some plantings have been made east of Watsonville in the same

districts that produce apricots. Most of the trees are old and do not produce very heavily.

Pears are grown chiefly in the mountainous districts and in small valleys far enough removed from the influence of coastal fogs. The Bartlett variety, especially, does not do well close to the coast. Yields range from 3 to 6 tons an acre, the trees in the mountains yielding less and the larger trees on the alluvial soils yielding more. Cultural methods are about the same as for apples.

Plantings of cherry trees are scattered throughout the area, but the largest acreage is in the district back of Soquel on soils of the Botella or Soquel series. There are also good cherry orchards near Corralitos and in Pleasant Valley. Favorable sites are those protected from the winds and on deep alluvial soils of medium texture. The varieties of cherries grown are the Black Tartarian, Bing, and Napoleon (Royal Ann). Yields range from 1 to 6 tons to the acre, although 3 tons is considered a good yield and 5 tons a large yield. Cherries are marketed through a cooperative association. The principal market is Los Angeles. The acreage of cherries is increasing slightly in these favorable districts, and the California Crop Reporting Service reported 501 acres of bearing trees in Santa Cruz County in 1937.

Peaches are not very important commercially, and the acreage in peach orchards is decreasing. The best sites are in protected valleys on deep alluvial soils of sandy loam, fine sandy loam, or loam texture. Most of the crop is marketed locally.

The acreage in grapes reached its peak about 1900, and since then it has decreased. The grapes are principally of the vinifera varieties, such as Zinfandel and Franken Riesling. Grapes are grown chiefly on the shallower residual soils of the Hugo, Cayucos, Santa Lucia, and Moro Cojo series. Yields are light, and the market is uncertain.

Hay and oats are grown in scattered areas on a wide variety of soils in the uplands and on the terraces. The soils of the bottom lands are so valuable for other crops that they are not used for these crops. Very little barley is grown. Oats are sown in the fall. Coastblack (California Black) and Red Rustproof (California Red) are the principal varieties of oats. Oats produce from 20 to 40 bushels an acre. The 1940 census reported 223 acres in oats in 1939, producing 13,902 bushels, or an average of about 62 bushels to the acre. Oats produce more heavily on the soils of the bottom lands, as much as 60 bushels an acre being reported a number of years ago. At present a mixture of oats and vetch is popular for hay and yields from 2 to 4 tons an acre. The average yield of grain hay as reported by the 1940 census was about 1.8 tons an acre. The acreage of grain and grain hay is gradually diminishing. As a general rule, barley is produced on the bottom lands or on the heavy-textured soils and oats on the sandy soils near the coast.

A wide variety of miscellaneous vegetable and field crops, including peas, tomatoes, potatoes, beans, corn, sugar beets, spinach, onions, garlic, cauliflower, carrots, and squash, are grown on both irrigated and nonirrigated land. Green peas are grown to some extent on the sandy coastal-plain soils or are occasionally used in crop rotations on the soils of the bottom lands. The acreage planted varies from year to year. Nearly all of the commercial plantings of these crops are

on the alluvial soils of the bottom lands. Muck and peat soils are of considerable value for the production of vegetables.

From 1,000 to 2,000 acres annually are devoted to tomatoes. The soils of the bottom lands produce large yields, especially of tomatoes for canning. The terrace soils of the Pinto and Watsonville series produce much less. The largest outlet is through canneries in San Jose.

The acreage in potatoes is diminishing rather rapidly. About 20 years ago the annual acreage ranged between 1,000 and 3,000 acres. The 1940 census reports 170 acres producing 8,930 100-pound bags in 1939, or an average of about 53 100-pound bags an acre. The acreage is scattered and in small holdings. Instead of being concentrated on the peat soils and soils of the bottom lands as it was 30 years ago, the production of potatoes is now concentrated on the soils of the terraces and sandy coastal plain. Potatoes planted in November or December and maturing in early spring are grown on Marina sand and Elkhorn sandy loam. The Garnet variety is the most popular. Medium or later varieties include British Queen, White Rose, and Burbank. Nitrogenous fertilizers increase the yields very materially. Fertilization is necessary on the sandy soils of the coastal plain, where yields have been increased 100 percent by using nitrates. Soils used for potatoes should be rotated with beans or other legumes.

Beans are grown on many farms as a rotation crop following such crops as brussels sprouts or lettuce. The principal varieties are the small white, Red Kidney, and cranberry beans. Horsebeans are grown chiefly for seed. Under irrigation the alluvial soils of the bottom lands produce between 15 and 30 sacks, and the nonirrigated terrace soils produce between 7 and 9 sacks to the acre.

Scattered plantings of early sweet corn are made in the area. The individual fields are not large, and the corn is marketed locally. It is grown on a wide variety of soils.

The growing of sugar beets was once an important enterprise on the alluvial soils of the Pajaro Valley when the beet-sugar factory in Watsonville was in operation. Until lettuce was introduced, a considerable acreage was planted annually to sugar beets on the Salinas soils in the lower part of the Pajaro Valley, which was too near the coast for the successful culture of apples. At present sugar beets are grown only in a few fields on the Salinas, Metz, and Botella soils. The beets are shipped to the beet-sugar factory in Salinas. Yields range from 10 to 25 tons an acre. The soils of the terraces and uplands are not adapted to the culture of sugar beets.

The commercial culture of bulbs is carried on along the coast between Santa Cruz and Aptos. A considerable acreage of eucalyptus, an Australian hardwood tree, occupies the Moro Cojo soils in Santa Cruz County and an area south of the Pajaro Valley in Monterey County. The young trees are set about 6 or 8 feet apart. The principal use of this tree is for firewood.

Poultry raising is one of the most important agricultural activities of Santa Cruz County. According to the California Agricultural Extension Service, about 450,000 chickens are produced annually, probably averaging about 900 chickens to a flock. The White Leghorn is the favorite breed. Poultry raising is centralized chiefly around Santa Cruz, in Scott Valley, in Green Valley, in the vicinity

of Freedom, and in the Aromas district. The equable climate is excellent for the health of the fowls. The poultry farms are exceedingly specialized. Poultry farmers usually have small farms and raise very little besides chickens. Feeds are purchased and eggs sold through cooperative agencies. The chief market for eggs and fowls is San Francisco. According to efficiency studies carried on over a 6-year period by the Agricultural Extension Service in Santa Cruz County, the average net returns are $1.11 a hen.

About 6,300 head of dairy cattle are kept in Santa Cruz County. The principal breeds are the Holstein-Friesian, Jersey, and Guernsey. The larger dairy herds are north of Santa Cruz along the coast, and smaller herds are in Scott Valley and in the Freedom district. The milk is marketed locally during the summer, and during the rest of the year the excess is shipped to San Francisco. Good pasture is obtained between November and May. The dairymen buy nearly all of their concentrates. Oat and vetch hay is produced on the farms. Crested wheatgrass, orchard grass, and Harding grass are recommended as good forage grasses. The raising of beef cattle is relatively unimportant in Santa Cruz County.

SOIL SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field.

The soils are examined systematically in many locations. Test pits are dug, borings are made, and exposures, such as those in road or railroad cuts, are studied. Each excavation exposes a series of distinct soil layers or horizons, called collectively the soil profile. Each horizon of the soil, as well as the parent material beneath the soil, is studied in detail; and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The reaction of the soil [6] and its content of lime and salts are determined by simple tests.[7] Drainage, both internal and external, and other external features, such as relief, or lay of the land, are taken into consideration, and the interrelation of soils and vegetation is studied.

The soils are classified according to their characteristics, both internal and external, special emphasis being given to those features influencing the adaptation of the land for the growing of crop plants, grasses, and trees. On the basis of these characteristics soils are grouped into mapping units. The three principal ones are (1) series, (2) type, and (3) phase. Areas of land such as coastal beach or bare rocky mountainsides that have no true soils are called (4) miscellaneous land types.

The most important group is the series, which includes soils having the same genetic horizons, similar in their important characteristics and arrangement in the soil profile, and developed from a particular type of parent material. Thus, the series includes soils having essentially the same color, structure, and other important internal characteristics and the same natural drainage conditions and range

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[6] The reaction of the soil is its degree of acidity or alkalinity expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality, higher values indicate alkalinity, and lower values indicate acidity.

[7] The total content of readily soluble salts is determined by the use of the electrolytic bridge. Phenolphthalein solution is used to detect a strong alkaline reaction.

in relief. The texture of the upper part of the soil, including that commonly plowed, may vary within a series. The soil series are given names of places or geographic features near which they were first found. Thus, Hugo, Pajaro, Watsonville, and Salinas are names of important soil series in the Santa Cruz area.

Within a soil series are one or more soil types, defined according to the texture of the upper part of the soil. Thus, the class name of the soil texture, such as sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam, and clay, is added to the series name to give the complete name of the soil type. For example, Hugo sandy loam and Hugo clay loam are soil types within the Hugo series. Except for the texture of the surface soil, these soil types have approximately the same internal and external characteristics. The soil type is the principal unit of mapping, and because of its specific character it is usually the soil unit to which agronomic data are definitely related.

A phase of a soil type is a variation within the type, which differs from the type in some minor soil characteristic that may have practical significance. Differences in relief, stoniness, and the degree of accelerated erosion are frequently shown as phases. For example, within the normal range of relief for a soil type, certain areas may be adapted to the use of machinery and the growth of cultivated crops and others may not. Even though no important differences are apparent in the soil itself or in its capability for the growth of native vegetation throughout the range in relief, important differences may exist in respect to the growth of cultivated crops. In such instances the more sloping parts of the soil type may be segregated on the map as sloping or hilly phases. Similarly, soils having differences in stoniness may be mapped as phases, even though these differences are not reflected in the character of the soil or in the growth of native plants.

The soil surveyor makes a map of the county or area, showing the location of each of the soil types, phases, and miscellaneous land types in relation to roads, houses, streams, lakes, section and township lines, and other local cultural and natural features of the landscape.

SOILS

Soils of the Santa Cruz area have been developed under subhumid to humid climatic conditions with an annual rainfall between 20 and 56 inches. With the exception of the recent alluvial soils that have been deposited by the Pajaro River, all the soils show an acid reaction by field test. Most of the soils of the uplands and terraces are acid, with a pH value of 5.3 to 5.8 in the surface soils and of 4.6 to 5.0 in the subsoils, indicating that the soils are low in bases.

As a general rule, the surface soils are fairly dark under virgin conditions, although many of the sandy soils soon change to a lighter color after they have been cultivated for some time and the organic matter has been oxidized and depleted. The soils of this area generally have a higher organic-matter content than those of the Great Valley of California, where the rainfall is much lower and the humidity also is lower. Under the fairly high rainfall of the area, many of the sandier soils are leached of plant nutrients; therefore they respond favorably to the application of fertilizers. Heavy applications of organic fertilizers, such as barnyard manures, give ex-

cellent results. Yields of crops have been doubled on the Elkhorn and Marina soils by the judicious use of fertilizers. The alluvial soils of the bottom lands are richer than other soils of the area in plant nutrients and organic matter, and tests conducted on them do not show so great a response to the use of fertilizers as on the soils of the terraces and uplands.

The soils differ considerably in their surface texture, depending chiefly on the type of parent material. Those soils that have their origin in coarse-textured igneous rocks, such as quartz diorite, produce sandy soils; for example, Holland sandy loam and Sheridan sandy loam. The same is true of those soils derived from the sandy coastal-plain deposits, such as Marina sand and Elkhorn sandy loam. The sandstone rocks produce sandy soils, and the shale rocks produce heavy-textured soils. With the exception of the area of igneous rocks west of Ben Lomond and Boulder Creek, the parent rock materials of the area are largely of sedimentary origin. The texture of the alluvial soils is governed by the character of the parent rocks and also by the velocity of the running water, by means of which the materials were transported and deposited. Again, the alluvial soils developed from materials eroded from igneous rocks are coarse textured, whereas those developed from the finer grained sedimentary rocks are finer textured or more clayey.

Differences in the mode of accumulation of the soil material, degree of weathering and soil development, rainfall, temperature, drainage, and parent material have had their effect in producing a number of different types of soils in this area. These different soils have been examined in the field and laboratory, classified, and mapped, and they are described in the following pages.

Soils developed over bedrock in the hilly and mountainous upland areas occur at elevations of 400 to 2,500 feet above sea level. These soils have been formed directly on the decomposed and disintegrated materials of the underlying consolidated parent rocks. The Hugo, Cayucos, Santa Lucia, Arnold, Holland, Sheridan, and Felton series all have soils that are acid in reaction but differ in color, profile, or mineralogical composition. Soils of many of the steeper slopes in the Santa Cruz Mountains are differentiated under the designation of steep phases; for example, Hugo loam, steep phase. These steep phases are essentially nonagricultural because of the steep slope, generally in excess of 25 percent. Where the soil cover is of sufficient depth, the soils of the hilly and mountainous areas support a good stand of trees. Redwoods are common in the canyons and on many of the slopes. Probably about 80 percent of these soils are in forest or brush. Small areas in the vicinity of Bonnie Doon, Castle Rock Ridge, northeast of Corralitos, and elsewhere have been cleared of the forest growth and planted to apples, prunes, plums, or pears. Here and there are a few plantings of grapes. These soils cover about 69 percent of the area surveyed.

Just below the higher hilly and mountainous areas are the soils that are developed on upland coastal-plain materials, representing about 6 percent of the area surveyed. These soils occupy high eroded terraces and include the soils of the Moro Cojo and Tierra series. The Moro Cojo soils are developed on soft sandstonelike material and the Tierra soils on heavier textured materials. The soils of both series occupy fairly steep slopes that erode severely. Generally speaking,

they do not have a very high agricultural value, owing to the very heavy clay subsoils of the Tierra soils and the extremely leached sandy character of the Moro Cojo soils.

The soils of the alluvial fans and stream bottoms are of alluvial deposition on smooth gently sloping alluvial fans or flood plains along the streams that rise in the mountains to the east. These soils apparently have been modified but little since deposition, and very little difference is evident between the surface soils and the subsoils. The soils of the Laguna, Soquel, Corralitos, Pajaro, and Botella series have their source of material in outwash from residual soils that are acid in reaction, and their reaction is similar. The soils of the Metz series occur as very recent alluvial deposits along the Pajaro River, which come from a distinctly semiarid section. The entire soil mass of the Metz soils is calcareous. The Salinas soils also represent young alluvial deposits of the Pajaro Valley. They have neutral or slightly alkaline surface soils and calcareous subsoils. The Alviso soils occur as saline alluvial and estuarine deposits just above tidal marsh. Highly organic muck and peat soils occur in a number of narrow valleys west of Watsonville and in one small body in Scott Valley. Most of the alluvial soils, with the exception of Alviso clay and the possible exception of some very sandy types, have a high agricultural value and are used for a wide range of crops, including lettuce, apples, berries, and miscellaneous truck crops. The largest area of bottom lands is in the southeastern part of the area in the vicinity of Watsonville. About 13 percent of the area surveyed consists of these soils.

Soils of the wind-modified coastal plain areas occupy sloping to gently undulating terraces at an elevation of approximately 50 to 200 feet above sea level. These border the coast line and have been developed on old sand dunes and sandy beach materials moved inland to a distance of about ½ to 1 mile. Soils of the Marina series occur just east of the sand dunes that border the coast and have young slightly modified profiles, as evidenced by slight compaction of the subsoil. These soils have an undulating surface on which a little movement of sand by wind may occur when the land is cultivated loosely or left without a vegetative cover (pl. 2, *A*). Soils of the Elkhorn series have a smoother surface, and they are more stable and less subject to wind modification than the related Marina soils. They have moderate compaction in the subsoil, although the subsoil is not very heavy textured. The Elkhorn soils represent an older stage in soil development of Marina materials. The soils of both series have a sandy texture and an acid reaction. They are low in organic matter and are not particularly fertile, but because of their sandy texture, which makes them a little warmer, they are used in many places for specialized winter crops, such as green peas and winter potatoes. Fertilization is usually necessary in order to produce good yields of these crops. These soils cover only a small area—less than 2 percent of the total area surveyed.

Occupying smooth terraces along the coast and above the recent and young alluvial soils of the stream valleys are a number of soils that apparently are older and have moderately dense to very dense subsoils. Ben Lomond loam, which appears to be the youngest of this group, has a moderately compact and heavy-textured subsoil. It occupies low terraces, alluvial fan slopes, and small valleys in the

mountainous district and has very little agricultural importance. The Pinto soils are extensive in the district north and northeast of Watsonville. They are of pronounced profile development with compact heavy-textured subsoils and substrata. Considerable acreage of apricots, strawberries, small fruits, and vegetables are grown on them. The soils of the Watsonville series are limited in their agricultural uses, owing to their leached surface soils and very heavy textured and relatively impervious subsoils. The Lockwood soils occupy smooth sloping terraces along the coastal plain north of Santa Cruz. They are immature to semimature in stage of profile development, have moderately dense subsoils, and are developed chiefly on outwash material from Monterey shale. In general they are bordered on the upland side by soils of the Santa Lucia series. With the exception of the soils of the Montezuma series, all these soils of the terraces have distinctly acid surface soils and subsoils. The Montezeuma soils occur on low undulating terraces along the north side of the Pajaro Valley just below the terrace occupied by Watsonville soils. They have heavy clay texture, dark color, and a nodular accumulation of lime at a depth of 28 to 34 inches. These soils aggregate about 10 percent of the total area surveyed.

TABLE 4.—*Acreage and proportionate extent of the soils mapped in the Santa Cruz area, Calif.*

Soil type	Acres	Percent	Soil type	Acres	Percent
Hugo sandy loam	5,248	1 8	Metz silt loam	704	0.2
Hugo sandy loam, steep phase	5,824	2 0	Metz silt loam, shallow phase (over Salinas soil material)	1,728	.6
Hugo fine sandy loam	1,728	.6	Soquel sandy loam	2,048	.7
Hugo fine sandy loam, steep phase	704	.2	Soquel loam	6,656	2 3
Hugo loam	11,840	4.1	Soquel loam, stony phase	320	.1
Hugo loam, steep phase	69,568	23 8	Soquel silty clay loam	1,088	.4
Hugo loam, shallow phase	960	.3	Laguna fine sand	3,456	1 2
Hugo clay loam	3,904	1.3	Alviso clay	448	.2
Hugo clay loam, steep phase	8,064	2 8	Pajaro sandy loam	768	.3
Cayucos sandy loam	1,152	4	Pajaro loam	2,752	.9
Cayucos loam	2,944	1 0	Pajaro clay loam	1,216	.4
Cayucos loam, steep phase	576	2	Botella clay loam	2,304	.8
Cayucos clay loam	2,304	8	Botella silty clay loam	1,664	.6
Cayucos clay loam, steep phase	2,432	8	Botella clay	1,152	.4
Santa Lucia clay loam	2,112	7	Salinas silty clay loam	1,664	.6
Santa Lucia clay loam, steep phase	10,944	3.8	Salinas silty clay	896	.3
Santa Lucia clay loam, shallow phase	18,688	6 4	Marina sand	1,280	.4
Santa Lucia clay	832	3	Elkhorn sandy loam	3,072	1 1
Santa Lucia clay, steep phase	2,240	8	Elkhorn loam	192	.1
Arnold sand	2,048	7	Ben Lomond loam	1,088	4
Arnold sand, steep phase	2,944	1 0	Ben Lomond loam, stony phase	1,152	.4
Holland sandy loam	2,048	7	Pinto sandy loam	1,408	5
Holland sandy loam, steep phase	6,784	2 3	Pinto loam	7,040	2 4
Holland fine sandy loam	320	1	Pinto loam, compact-subsoil phase	2,432	8
Holland fine sandy loam, steep phase	64	(1)	Pinto clay loam	320	.1
Sheridan sandy loam	2,432	8	Lockwood loam	1,600	5
Sheridan sandy loam, steep phase	3,904	1.3	Watsonville sandy loam	3,648	1 3
Sheridan loam	2,688	9	Watsonville loam	8,256	2 8
Sheridan loam, steep phase	4,480	1 5	Watsonville loam, shallow phase	576	.2
Felton loam	2,304	8	Watsonville clay loam	1,344	.5
Felton loam, steep phase	4,544	1.6	Montezuma adobe clay	1,280	.4
Felton stony sandy loam	640	2	Muck and peat	1,216	.4
Moro Cojo loamy sand	8,448	2 9	Marsh	192	.1
Moro Cojo sandy loam	2,624	.9	Tidal marsh	320	.1
Moro Cojo gravelly loam	1,472	5	Coastal beach and dune sand	704	2
Tierra loam	3,072	1.1	Riverwash	320	.1
Tierra clay loam	576	2	Rough stony land (Holland soil material)	384	.1
Corralitos sand	4,288	1.5	Rough stony land (Hugo soil material)	13,312	4.6
Corralitos sand, shallow phase (over Botella soil material)	192	1	Total	291,840	100.0
Corralitos sandy loam	1,728	.6			
Metz fine sandy loam	1,792	.6			
Metz fine sandy loam, shallow phase (over Salinas soil material)	384	1			

[1] Less than 0.1 percent.

Twenty-four different series of soils represented by 73 soil types and phases, together with 7 miscellaneous classes of material (muck and peat, marsh, tidal marsh, coastal beach and dune sand, two classes of rough stony land, and riverwash), were recognized and mapped in the soil survey of the Santa Cruz area. In the following pages the different soils of the area are described, and their agricultural relationships are discussed; their location and distribution are shown on the accompanying soil map, and their acreage and proportionate extent are given in table 4.

HUGO SERIES

The soils of the Hugo series are developed in place on weathered sandstone and shale bedrock. They are formed under conditions of fairly high rainfall. These soils occupy rolling to fairly rough relief (pl. 1, *A*); therefore the runoff in most places is fairly rapid, and most cultivated or cleared areas have suffered to a considerable degree from erosion. The native vegetation consists of redwood, madrone, oak, and other hardwoods in the valleys and on the north slopes. Less redwood and more hardwood and brush, such as manzanita and buckbrush, cover the south slopes. Some Douglas-fir grows on the ridges and a few ponderosa pine on the sandier areas. Where the soil is shallow, brush is the native vegetation.

The surface soils, to a depth ranging from 4 to 18 inches, are grayish brown or dull grayish brown and have no definite structure, except the immediate surface layer, which is somewhat granular. The surface soils are thoroughly penetrated by worm and insect holes. The subsoils are yellowish brown or lighter grayish brown and have no characteristic structural form in place, although they break into fairly hard lumps or clods when disturbed. They are moderately compact, containing more colloidal clay than the surface soils. When wet they are fairly plastic and sticky. The surface soils have an acid reaction, and the acidity increases in the lower layers. These soils show a pH value[8] of 4.8 to 6.0 in the surface layers and 4.5 and 5.5 in the subsoil layers.

Parent bedrock lies at a depth ranging from 1 to 6 feet. It is broken to some extent in the topmost part with some infiltration of soil into the crevices. The weathering and breakage of the topmost part of the bedrock gives added soil material so that roots are able to obtain moisture and some sustenance in the cracks. Under cultivation the Hugo soils have a tendency to puddle, thereby increasing runoff from the surface.

The Hugo soils are closely associated with the Cayucos soils but are lighter colored and differ in other characteristics. In the earlier reconnaissance soil survey of the San Francisco Bay region (*6*), the Hugo soils were included with soils of the Altamont series, from which the Hugo soils, a more recently established series, differ mainly in a more acid reaction.

Hugo sandy loam.—The surface soil of Hugo sandy loam is light-brown to dull grayish-brown sandy loam to a depth of 10 to 15 inches. It is deep brown or dull yellowish brown when moist. Many small

[8] Where not otherwise indicated the pH values referred to in the descriptions of soil series and types are based on field tests with Soiltex or LaMotte colorometric methods. These tests give approximate determinations, but they are less precise and less accurate than results of laboratory determinations given in a later section of this report.

spots of darker colored surface soil occurring at the foot of slopes and in depressions are included. The soil is covered with a layer of brown partly decomposed forest litter about 2 inches thick on uncleared areas. The surface soil is moderately acid, the pH value ranging from 4.8 to 5.5.

The subsoil is light grayish-brown or yellowish-brown to brownish-yellow sandy loam or coarse sandy clay loam to an average depth of about 30 inches, where it is underlain by yellowish-brown partly disintegrated sandstone. Many small angular fragments of sandstone are in the soil in places. The subsoil is slightly less acid than the surface soil, the pH value being about 5.8.

Hugo sandy loam is a variable soil. The depth to bedrock ranges from 12 to 48 or more inches within short distances. The soil is coarse and sandy on the slopes and more loamy in the depressions. The organic-matter content is rather low.

This soil is fairly fertile and has a fair to rather low water-holding capacity. Most of the cultivated areas are at the foot of slopes where they receive some runoff from surrounding areas. Very little commercial fertilizer is used on this soil. Most areas are rolling, with a slope ranging from 10 to 15 percent. Areas having a slope of more than 25 percent are differentiated as a steep phase.

Small areas northeast of Aptos differ from the typical soil in having a compact sandy clay loam subsoil at a depth ranging from 28 to 48 inches below the surface. This soil is included in mapping owing to its small extent. As a general rule, areas of this inclusion are somewhat smoother than areas of typical Hugo sandy loam. Apple trees do not appear thrifty, and yields are lower than on soils having more permeable subsoils.

About 25 percent of Hugo sandy loam is under cultivation. Grapes, the most important crop (pl. 1, *A*), yield about 2 tons an acre. Some apples, pears, cherries, and apricots are grown. Apples yield about 200 boxes an acre and pears 1½ tons.

The uncleared areas are covered with redwood, madrone, oaks, Douglas-fir, ponderosa pine, holly, poison-oak, manzanita, buckbrush, and other trees and shrubs.

Small bodies of Hugo sandy loam are scattered over the area, the largest being in the north-central part of the county.

Hugo sandy loam, steep phase.—Hugo sandy loam, steep phase, is similar to typical Hugo sandy loam, except for the difference in slope of the land. The relief is steep and mountainous, and slopes range from 25 to more than 50 percent. Many rock outcrops are at the crests of the slopes and in gullies. The soil is deep in many places at the foot of slopes because of the accumulation of colluvial material. Some areas of loamy sand texture are included in mapping. The largest of these are near Mountain View Ranch.

Practically none of this steep soil is cultivated. A few small spots in the northeastern part of the county are devoted to grapes, but the land is badly eroded.

The native cover on the uncleared areas consists largely of second-growth redwood and some Douglas-fir on the north slopes and in the valleys. Madrone, scrub oak, manzanita, poison-oak, and buckbrush cover most of the south slopes and occur as underbrush in other areas. Ponderosa pine trees grow in a few places.

Hugo fine sandy loam.—Hugo fine sandy loam is dull grayish-brown fine sandy loam of smooth even texture, to a depth of 12 or 15 inches. It is deep brown when moist and grayer when dry. It contains a few angular fine-grained sandstone fragments. The surface soil ranges from moderately acid to slightly acid, with a pH value of 4.8 to 5.8.

The upper part of the subsoil is grayish-brown or yellowish-brown smooth fine sandy loam continuing to an average depth of about 36 inches. It breaks to irregular chunks that are easily pulverized. The material in this layer is moderately acid, with a pH value ranging from 4.7 to 5.3. It contains a considerable quantity of angular fine-grained sandstone fragments in the lower part. Many rootlets extend to the lower part of the subsoil. The subsoil is underlain by grayish-brown, yellowish-brown, or brownish-yellow partly disintegrated fine-grained sandstone. The depth to the sandstone ranges from 24 to 48 or more inches.

This is an easy soil to cultivate and is rententive of moisture, which penetrates deeply. Fruit trees produce fairly good crops without irrigation. Practically no commercial fertilizers are used. The organic-matter content is rather low.

The relief is rolling, with an average slope between 5 and 15 percent. Areas having a slope of more than 25 percent are differentiated on the map as a steep phase. The largest areas are on Castle Rock Ridge and near Bonny Doon, but small bodies are scattered over the northern part of Santa Cruz County.

Probably 60 percent of this soil is devoted to fruit and 20 percent to other crops. French prunes are grown on about 35 percent of the area devoted to fruit. This is the favorite soil for prunes in the northern part of the Santa Cruz area because it produces rather large fruit. The average yield is about 1 ton of dried prunes to the acre. Pears are grown on about 25 percent, apples on about 20 percent, and grapes on about 15 percent of the land devoted to fruit. Pears yield about 2½ to 3 tons an acre, apples about 350 boxes, and grapes 2 tons. Some scattered areas are planted to German prunes, apricots, cherries, and peaches. The uncleared areas are covered with second-growth redwood, madrone, oaks, and underbrush.

Hugo fine sandy loam, steep phase.—The surface soil of Hugo fine sandy loam, steep phase, is light grayish-brown fine sandy loam to a depth of about 12 inches, and the subsoil is grayish-brown or yellowish-brown fine sandy loam. At a depth of about 28 inches is brownish-yellow partly disintegrated sandstone that is fairly hard where unweathered.

Rock outcrops in many places, and many angular sandstone fragments are scattered over the surface. This steep phase is similar to typical Hugo fine sandy loam, except that it is more variable and shallower to bedrock. The depth to the sandstone bedrock varies greatly, owing to the steep mountainous relief. The slope ranges from 25 to 50 or more percent. None of this steep land is farmed. The native cover consists of madrone, second-growth redwood, Douglas-fir, oaks, laurel, holly, and underbrush.

Hugo loam.—The surface soil of Hugo loam is grayish-brown loam to a depth of 10 to 15 inches. It is grayish-brown when dry and brown when moist. It is smooth and friable, with a very faintly

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granular structure, and is permeated by small roots. Soil aggregates ranging from the size of a pea to a small nut cling to the roots. The surface soil is moderately acid to slightly acid, with a pH value ranging from 4.8 to 6.4. A 2-inch layer of rather dark brown partly decomposed forest litter covers the soil in the uncleared areas. The upper subsoil layer is grayish-brown or yellowish-brown loam that is slightly more compact than the surface soil, and in included areas the texture of this layer is heavier. The material is yellowish-brown when moist. It breaks to irregular rounded clods along faint vertical fissures. Old root channels give the clods a slightly vesicular appearance. This horizon is moderately acid, with a pH value ranging from 4.6 to 5.6. It is distinctly more acid than the surface soil. Fragments of shale and fine-grained sandstone, the number increasing with depth, are scattered throughout the surface soil and the subsoil. At an average depth of about 40 inches the subsoil grades into disintegrated shale or fine-grained sandstone containing yellowish-brown to light grayish-brown gritty loam interstitial material. This material crumbles readily and ranges from 10 to 20 inches in thickness. It passes directly into highly crumpled and folded sandy shale or fine-grained standstone.

Like most of the well-drained soils developed under a forest cover, Hugo loam contains little organic material. Practically none of the land is irrigated. Much of it occupies the tops of ridges where the slopes range from 10 to 15 percent, and in most areas the slope is sufficient to interfere with cultivation. Areas having a slope of more than 25 percent are mapped as a steep phase. Terracing and plowing on the contour are seldom practiced. Sheet erosion has removed much of the surface soil from many of the older cultivated areas, even though this soil is fairly resistant to erosion. All the soil is well drained.

Hugo loam, together with its steep phase, is the predominating soil in the uplands of Santa Cruz County, except on Ben Lomond Mountain northwest of Santa Cruz and in the southeastern part. It covers 18.5 square miles. Typically, Hugo loam occurs largely in small bodies surrounded by areas of the more extensive steep phase. and it is closely associated with the Cayucos soils. The largest areas are in the north-central part of the area. Some spots included with this soil as mapped, especially north and east of Skyland Ridge, have a redder subsoil than does the typical soil.

Probably 30 percent of the land is used for fruits and grapes and 15 percent for hay and truck crops. Prunes, apples, grapes, pears, cherries, plums, and apricots are the most important fruits grown. Apples yield from 200 to 350 boxes an acre, prunes 1 ton, grapes 2 tons, and pears 2½ tons. Grain cut for hay yields about 1½ tons.

The native vegetation consists largely of redwood, tan oak (locally known as tanbark oak), coast live oak, madrone, and laurel. Some Douglas-fir grows on the ridges, much underbrush is in the forested areas, and manzanita, poison-oak, buckbrush, and wild lilac are common on shallow and burned-over areas.

Hugo loam, steep phase.—Hugo loam, steep phase, is similar to typical Hugo loam, except that it is shallower and is more variable, owing to the steep relief. Most of this steep soil has a slope ranging from 25 to 50 percent, but it includes small areas with more gentle slope on the tops of ridges and in the troughs of valleys. The soil is

distinctly darker in the depressions than on the ridges. The south slopes are generally steeper, and the soil is shallower than on the north slopes. Outcrops of shale and sandstone are numerous. This soil in general is deeper in the southeastern part of the area and shallower in the northern and northwestern parts. Areas bordering Hugo loam, shallow phase, have a shallower soil than typical soil. As mapped, the texture of the surface soil is dominantly loam, but it includes clay loam and fine sandy loam variations.

Less than one-half percent of the soil of this phase is cultivated. The valleys and north slopes were formerly covered with redwood yielding about 40,000 feet of merchantable timber to the acre. Most of the areas have been cut-over, and oaks, madrone, poison-oak, laurel, holly, and young redwood and Douglas-fir now cover much of the land. Most of the south slopes are covered with manzanita, madrone, oaks, buckbrush, poison-oak, and other shrubs.

Hugo loam, steep phase, by far the most extensive soil in the area, covers 108.7 square miles. It has considerable value for use as summer home sites and country estates for people who live in the cities, and most of the houses shown on the soil map on areas of this soil are used for that purpose. This use for recreational purposes gives the soil near good roads a high acre value.

Hugo loam, shallow phase.—Hugo loam, shallow phase, has a surface soil consisting of light grayish-brown gritty loam to a depth of 6 to 12 inches, where it passes into grayish-brown to reddish-brown gritty loam. Shale and sandstone fragments are scattered over the surface, and the quantity increases with depth. At a depth ranging from 10 to 30 inches the soil grades into disintegrated shale or sandstone.

This shallow soil covers only a small area, mainly on the crest of the Santa Cruz Mountains east of Highland School. It has little agricultural value, but a few spots are used for grapes. Manzanita, a few scrubby oaks, madrone, holly, buckbrush, and other shrubs make up the vegetation.

Included with this soil as mapped are areas that occupy steep slopes and have many rock outcrops and spots that are barren of soil material. Such areas are along the northeastern county line, south of the Santa Cruz Mountains. These inclusions have no agricultural value, owing to their shallowness and steep slope. Most of them are covered with madrone, rather scrubby oak, manzanita, poison-oak, holly, buckbrush, and other shrubs, but some are bare of vegetation.

Hugo clay loam.—The surface soil of Hugo clay loam is light grayish-brown clay loam with a faint yellow shade, which extends to a depth of 12 to 15 inches. The soil is gray when dry and deep brown when moist. It has a smooth uniform silty texture and contains a few soft shale fragments. The structure is faintly granular, and soil particles cling to the small roots in pea-sized to small nut-sized aggregates. The material is faintly to moderately acid, with a pH value ranging from 5.0 to 6.4.

The upper subsoil layer, at a depth between 12 and 15 inches and extending to a depth of about 42 inches, is yellowish-brown to grayish-brown clay loam. It breaks into irregular chunks without definite fissure planes. The material contains many rootlets and old

fine root channels, which give it a vesicular appearance. The material becomes very dry in late summer but is not particularly compact. It is slightly heavier in texture than the surface soil and is more acid, with a pH value ranging from 4.8 to 5.6. The quantity of shale fragments increases with depth, and this layer grades into grayish-brown, yellowish-brown, or brownish-yellow shaly clay loam containing specks of rust brown and faint streaks of gray. This is a disintegrated shale with clay loam interstitial material. At a depth ranging from 3 to 8 feet it passes into highly folded crumpled shale.

The soil is sticky and difficult to plow when wet, and the organic-matter content is rather low. Practically no commercial fertilizer is used. The surface is rolling, and the slope ranges from 7 to 25 percent. Most of this soil occupies the higher elevations where no water is available for irrigation. The comparatively steep slopes make cultivation difficult and the soil susceptible to erosion. Surface drainage is excessive, and underdrainage in most places is good.

The largest areas are near Laurel, north of Boulder Creek, and in California Redwood Park, but the total area is small. This soil is closely associated with Hugo loam and as mapped includes some small spots of silty clay loam texture.

About 50 percent of the land is under cultivation. The crops grown are similar to those grown on Hugo loam. Farmers consider Hugo clay loam more desirable than Hugo loam for hay, slightly more desirable for apples and pears, and less desirable for prunes. Most of the uncleared areas are covered with a young stand of redwood trees with some oaks, madrone, laurel, Douglas-fir, and other trees.

Hugo clay loam, steep phase.—Hugo clay loam, steep phase, is similar to typical Hugo clay loam except for its steep, broken relief. The soil is more variable, especially in the depth to bedrock. It is shallow near the upper part of the slopes and deeper near the bases. The soil is darker colored in the troughs and lighter colored on the ridges. It includes many partly disintegrated shale fragments, and bedrock outcrops in the gullies and at sharp breaks on the ridges.

Soil of this phase has little agricultural value, owing to its steepness. Some of the smoother areas could be farmed if terraced to prevent erosion. The land is more valuable for the production of timber, and most of it was formerly covered with a stand of redwood running about 40,000 board feet to the acre. Most of it now supports a young growth of redwood trees, some oaks, madrone, laurel, Douglas-fir, and a thick underbrush. This soil is of little value for grazing.

Some areas of Hugo clay loam, steep phase, were included with the steep phase of Hugo loam, owing to similarity and difficult accessibility. The largest areas of Hugo clay loam, steep phase, are near Laurel, north of Boulder Creek, and in California Redwood Park. As mapped, soil of the steep phase includes a small body of a heavier textured soil about one-half square mile in area near Chittenden. This body is very steep, and if this material were more extensive it would be recognized as Hugo clay, steep phase.

CAYUCOS SERIES

The soils of the Cayucos series are developed in place on weathered sandstone and shale bedrock. They are formed under fairly high

rainfall, characteristic of the Santa Cruz Mountains. They occur to a considerable extent on the flatter areas, in swales, and at the foot of slopes in the mountains where they are subject to runoff from more elevated soils.

The native vegetation consists of redwood, madrone, and oak; and, where the soils are shallow, more brush grows. Runoff is fairly rapid, although not so rapid as on the related Hugo soils. As a general rule, the Cayucos soils are well drained.

The surface soils, to a depth of about 15 inches, are dark brownish gray to dark gray, becoming almost black when wet. These soils are fairly granular and contain a fair quantity of organic matter, generally considerably more than the related Hugo soils. The subsoils are dark brown, dark grayish brown, and, in places, lighter grayish brown in the lower part. In a few places yellowish-brown material immediately overlies the parent bedrock. These soils have no characteristic structure in place but break into irregular clods when disturbed. They are moderately compact, containing considerably more colloidal clay than the surface soils. When wet they are fairly plastic and sticky.

The surface soils are acid in reaction, and the acidity increases in the lower horizons. The soil material has a pH value of 5.0 to 6.5 in the surface horizons and from 4.5 to 5.5 in the subsoils. These soils are not so acid, however, particularly in the surface horizons, as the related Hugo soils. Fragments of sandstone and shale bedrock occur throughout the soil mass, and parent bedrock generally lies from 1 to 6 feet below the surface. The topmost part of the bedrock is weathered and broken to some extent so that moisture and roots can penetrate these softer spots.

The Cayucos soils in this area are closely associated with the Hugo soils but have a darker color and differ in other minor characteristics.

Cayucos sandy loam.—The surface soil of Cayucos sandy loam is very dark grayish-brown fine-textured sandy loam to a depth of 12 to 15 inches. The surface soil has a good organic-matter content, and when moist it is distinctly loamy. It is acid, with a pH value ranging from about 4.8 to 5.5. This layer grades into an upper subsoil layer of dark grayish-brown fine sandy loam or sandy clay, which also is moderately acid. Between depths of 36 and 60 inches the lower subsoil layer is grayish-brown to yellowish-brown sandy loam containing more or less sandstone and sandy shale fragments. This material is very acid, with a pH value ranging from 4.7 to 5.3. It rests on the brownish-yellow to grayish-yellow sandstone parent material, generally within a depth of 80 inches.

As mapped, small areas of very fine sandy loam and loamy sand are included. This soil is developed in small scattered bodies, mostly in depressions and in benchlike areas at the foot of slopes. The total area is small.

Possibly 25 percent of the land is under cultivation. It is used for truck crops and fruits. Fruit trees do not appear to be thrifty, but truck crops do well. The uncleared areas are covered with redwood, Douglas-fir, madrone, a few ponderosa pine, and some hardwoods.

Cayucos loam.—The 15-inch surface soil of Cayucos loam is very dark brown loam having a faint granular structure. The soil is very dark when moist but is grayer when dry. It contains many grass

roots, to which the soil aggregates cling. The material is smooth and friable and pulverizes readily. It is slightly acid, with a pH value of about 5.7. This layer grades into a dark-brown or grayish-brown upper subsoil layer of loam or silt loam texture, which has a faint yellow shade and becomes lighter in color with depth. The upper subsoil layer has an irregular nut to a small cloddy structure that is faintly vesicular. The texture is slightly finer or heavier than the material in the layer above. It contains a few small fragments of shale and fine-grained sandstone. The lower subsoil layer, at a depth ranging from 30 to 50 inches, is grayish-brown or yellowish-brown to brownish-gray heavy loam containing particles and fragments of disintegrated shale or sandstone, which increase in quantity with depth. It breaks into angular fragments more or less parallel with the planes of the parent rock. The material in the lower part of the subsoil is distinctly acid, with a pH value ranging from 4.7 to 5.6. This layer rests on the parent rock—a grayish-brown and yellowish-brown partly disintegrated sandy shale or fine-grained sandstone. The depth to the parent rock ranges from 36 to 80 inches.

As mapped, Cayucos loam includes a few small spots having a somewhat heavier textured layer and a faint columnar structure at a depth of 24 to 30 inches. This layer contains specks of rust brown and a faint coating of gray on the fissure planes.

The surface soil contains a fair to moderate quantity of organic matter. The soil retains moisture well, crops on it withstand drought well, and fairly good crops of fruit are produced with no summer rain. The land is fertile, and practically no commercial fertilizer is used.

Cayucos loam occurs chiefly at the foot of slopes and in valley troughs where it receives some runoff from the slopes above. Surface drainage and underdrainage are adequate. The slope of most areas does not interfere greatly with cultivation, as it ranges generally from 5 to 15 percent, being greater than 25 percent in very few places.

The largest bodies are northeast and northwest of Corralitos, near Skyland Ridge, and near Branciforte Creek, and small scattered bodies are elsewhere over the area. The total area is small.

Probably 70 percent of this soil is under cultivation. It is used mostly for fruit, especially apples, pears, grapes, French prunes, cherries, and apricots. Apples yield from 200 to 600 boxes an acre, averaging about 400 boxes; pears 3 tons, grapes 1 to 2 tons, and prunes 1½ tons. The average yield of cherries has been about 1.4 tons an acre, but crops have been uncertain in recent years. Small areas are devoted to tomatoes and other truck crops. The uncleared areas are covered with redwood, some oak, madrone, laurel, and underbrush.

Cayucos loam, steep phase.—This soil is similar to typical Cayucos loam. The surface soil is dark grayish brown or dark brownish gray, and the subsoil generally is somewhat lighter colored, slightly heavier textured, and more compact than the surface soil. This soil has a steeper relief than typical Cayucos loam, most of the slopes being in excess of 25 percent.

The native vegetation consists of redwood, some oak, madrone, and laurel. Parent bedrock lies from 1 to 6 feet or more below the surface. Because of its steep slope, this land is not adapted to tilled crops. Erosion is very active in areas that have been tilled or where the native cover has been removed. Protection of this soil from erosion depends

on a good cover of grass, brush, or trees. The greater part of the land consists of fairly good forest land.

Cayucos clay loam.—The surface soil of Cayucos clay loam is smooth-textured clay loam to a depth of about 15 inches. It breaks into irregular somewhat rounded clods that crush to a faintly granular structure. This soil is very dark brown when moist and dark grayish brown when dry. A 2-inch layer of partly decayed forest litter covers the surface in forested areas. The surface soil is slightly acid, the pH value ranging from 6.0 to 6.5. The upper subsoil layer, which reaches a depth of 30 inches, is dark-brown clay loam with a faint yellow or gray cast. It breaks into faintly vesicular angular fragments or chunks having a rough surface. It is slightly to moderately acid, with a pH value ranging from 5.5 to 6.5. The lower subsoil layer is lighter grayish brown or lighter yellowish brown and is slightly more acid than the upper subsoil layer. At a depth of about 45 inches is the parent material of brownish-yellow, grayish-brown, or yellowish-brown disintegrated shale or sandy shale, which is highly crumpled and folded. It is strongly to medium acid, with a pH value ranging from 5.2 to 5.7.

The surface soil has a fair to moderate content of organic matter. This soil is permeable to moisture and has a good water-holding capacity. It is a fertile soil and produces fairly good crops of fruit without irrigation or commercial fertilizer.

For the most part, this soil occupies sloping benchlike areas on hillsides and in troughs and depressions. It occurs mainly in a few fairly large bodies in the southeastern part of the area, along the Santa Cruz-Santa Clara County line. Most of this land has a slope ranging from 5 to 15 percent. It is closely associated with Hugo clay loam.

Probably 65 percent of this soil in the Skyland district is under cultivation. It is used largely for apples, pears, grapes, cherries, apricots, and other fruits, and the yields are about the same as those on Cayucos loam. Most of the uncleared areas are covered with second-growth redwood, together with some madrone, oaks, laurel, holly, and underbrush. The area north of Chittenden, along the county line, is farmed to grain and beans or is left in pasture. Much of this area was under a natural grass cover with the more protected north slopes in forest—mostly redwood and madrone.

The areas of Cayucos clay loam that occur near Chittenden differ from the typical soil in that they are of clay texture. If these areas were more extensive they would be classed as Cayucos clay. The surface soil in these areas consists of dark brownish-gray clay. Compared with the corresponding layer in the typical soil, the subsoil is of about the same texture, slightly more compact, and generally somewhat lighter colored. Both the surface soil and the subsoil are slightly acid. Fine-textured shale bedrock occurs from 2 to 4 feet below the surface. The native vegetation in the areas south of Chittenden consists primarily of grass and a few scattered oaks. The land is used for pasture or grain. Erosion is active on areas that are uncultivated and do not have any vegetative cover.

Cayucos clay loam, steep phase.—Cayucos clay loam, steep phase, is similar to typical Cayucos clay loam but differs in that it occurs on steep slopes ranging from 25 to 50 percent or more. Because of these

steep slopes, it is not adapted to tilled crops. Where the native cover, whether it be grass, forest trees, or brush, is removed, the land erodes considerably. Areas of the deeper soil support a good stand of commercial timber.

The surface soil is dark grayish brown or dark brownish gray and generally extends to a depth ranging from 6 to 20 inches. When wet, the soil is dark gray or black. In forested areas a 2-inch layer of decayed forest litter covers the surface in most places. The subsoil is generally of a slightly heavier texture than the surface soil and is moderately compact. It contains sufficient colloidal clay to bind the material together and cause a cloddy structure. The surface soil has an acid reaction, and the acidity increases in the lower horizons. In most places bedrock lies at a depth ranging from 1 to 6 feet.

SANTA LUCIA SERIES

The Santa Lucia series includes soils developed in place from the disintegration and decomposition of siliceous shale (Monterey shale). They occur under a rainfall of 30 to 50 inches. Most of these soils occupy fairly steep slopes, and the relief ranges from rolling to very steep. Slopes that have a good supply of moisture support a cover of redwood, laurel, oak, and madrone, but the characteristic cover is grass, together with scattered brush and scrubby oaks. Runoff is very rapid, and cleared areas erode very badly.

The surface soils, to a depth of 8 to 18 inches, are dull grayish brown to dark brownish gray and medium to heavy textured. They are fairly friable and break into a granular or small cloddy structure. They are permeable to roots and moisture, rather high in organic matter, and generally strongly acid in reaction. The subsoils are dull grayish brown to brownish gray and are slightly more compact and slightly heavier textured than the surface soils. They break into rather angular clods or blocks, which are more difficult to crush than the broken surface soil. Many worm, root, and insect holes occur throughout both the surface soils and the subsoils. The subsoils are generally somewhat more acid in reaction than the surface soils. Numerous angular siliceous shale fragments are present throughout the entire soil mass. The disintegrated fragments of shale grade into the massive shale bedrock at a depth ranging from a few inches to about 3 feet.

At the time of the earlier survey of the San Francisco Bay region (*6*) the Santa Lucia series had not been recognized, and the materials of this series of soils were included mainly with the Altamont soils. The Altamont soils developed on sandstone and shale materials and are irregularly calcareous in the subsoils. They are now recognized as being out of place in the areas having higher rainfall and acid soils, such as those in the Santa Cruz area.

Santa Lucia clay loam.—The surface soil of Santa Lucia clay loam, to a depth of 6 to 12 inches, is dark dull grayish-brown somewhat cloddy to granular friable clay loam. It is very permeable to roots and moisture, fairly high in organic matter, strongly acid, and not very fertile. It contains a variable quantity of angular shell fragments. The subsoil, extending to a depth of 18 to 30 inches, is dull brownish-gray slightly compact clay loam, which breaks into rather blocky clods with angular corners; yet the clods are friable

and easily broken. The material in this layer is permeable to moisture and roots, is strongly acid, and contains more angular shale fragments than the surface soil. It rests on broken angular shale particles that grade into rather massive shale bedrock.

The shale fragments in the soil mass are not sufficiently abundant to interfere with tillage operations, and they help somewhat in preventing the soil from baking when dry. The soil absorbs water well and has a fairly high water-holding capacity, but it is so shallow that it cannot store sufficient water for the normal needs of most plants. As this soil is developed from siliceous strongly acid marine shale, it is not very fertile. Cleared areas erode rather badly.

This soil occurs along the coast, west and northwest of Santa Cruz, in hilly areas above the coastal plain. It is not very extensive and comprises only a small part of the soil developed from Monterey shale. It occupies smooth sloping ridges and hillsides.

Under natural conditions and on protected north slopes, this soil supports some redwood, fir, laurel, oak, and madrone, but normally the cover is scrubby oak and brush. About the only use made of the cleared areas is for grain hay and pasture. The yields of grain hay are rather low.

Santa Lucia clay loam, steep phase.—The steep phase of Santa Lucia clay loam has soil material almost identical in profile with that of typical Santa Lucia clay loam, but most of it occurs on slopes of more than 25 percent. It is permeable to roots and moisture and has a fairly high organic-matter content and a moderately acid reaction. The subsoil is slightly heavier textured than the surface soil and contains a considerable quantity of angular shale. The depth of soil material over bedrock ranges from a few inches to 6 feet.

The native cover consists of grass, brush, or trees. Trees generally grow on the deeper soil, whereas brush covers the shallower soil. The grass-covered areas are used for grazing. This steep soil is nontillable because of its steep slope and slight depth. The more shallow areas are practically devoid of soil material and are indicated on the soil map by rock outcrop symbols. They are most prominent in the northwestern part of the area, where they are locally known as "the chalks." They support only a stunted growth of manzanita and fourwing saltbush (chamiso). Runoff is excessive, and the surface is dissected by numerous gullies caused by erosion.

Santa Lucia clay loam, shallow phase.—Santa Lucia clay loam, shallow phase, consists of dull grayish-brown clay loam containing many angular shale fragments. It is fairly friable and has a granular structure and moderate to high acidity. The subsoil is lacking in many places, and where present it is very thin and is somewhat lighter colored, more compact, and slightly heavier textured than the surface soil. Underlying siliceous shale bedrock occurs at a depth of 4 to 12 inches. This shallow soil occupies rolling areas. The smoother areas support some grass, and trees grow in places where the soil is deeper. Low-growing brush is the dominant cover on the areas of shallower and steeper soil. The grass-covered areas have some grazing value, but the brush-covered areas have very little economic use except for preservation of the watershed.

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Santa Lucia clay.—The 12- to 20-inch surface soil of Santa Lucia clay is dark brownish-gray or dull dark grayish-brown rather loose and friable clay that appears to be of lighter texture than the clay loam. It is strongly acid, has a rather high content of organic matter, is rather retentive of moisture, and contains considerable angular shale fragments throughout. Roots and water readily penetrate it. The subsoil, to a depth of 20 to 32 inches, is dull-brown or grayish-brown slightly compact light-textured clay with a somewhat cloddy structure, yet it is easily broken down. This layer contains numerous angular shale fragments. The material is permeable to roots and water and is strongly acid. The subsoil rests on disintegrating Monterey shale.

This soil is not extensive. One body occurs in the northwestern part of the area near Whitehouse Creek. Several bodies in the southern end of the area north of Chittenden include a soil that is not developed wholly from the Monterey shale but partly from the softer shales. This inclusion is somewhat like the soils of the Cayucos series but is shallower and has some angular fragments of Monterey shale throughout the soil mass. It is more fertile than the soil formed entirely from Monterey shale.

This soil supports a native cover of brush, grasses, and, on the protected north slopes, a few trees. Some grain and beans are grown around Chittenden, and the yields are only slightly inferior to those obtained on the Cayucos and Hugo soils. Santa Lucia clay has good surface and subsoil drainage, and where cleared or in native grasses it is better adapted to pasture than to any other agricultural use.

Santa Lucia clay, steep phase.—This steep soil has a profile similar to that of typical Santa Lucia clay, but it occupies steeper slopes. Except where it supports a natural grass cover and can be used for pasture, it has no agricultural value. The area along Whitehouse Creek in the northwestern part of the area can be considered, in part at least, as potential forest land.

ARNOLD SERIES

The Arnold series includes residual soils developed in place from light-colored coarse-textured sandstone. They occur in the uplands where the relief is rolling to steep. Runoff is rapid. Areas not having a vegetative cover erode very badly, and the eroded areas are extensive. Drainage is generally good. The native vegetation consists of scattered ponderosa pine, knob-cone pine, brush, and some fir on the open spots. The Arnold soils are generally bordered by the Hugo and Santa Lucia soils, which have similar relief, but they differ from those soils in color, mineralogical composition, organic-matter content, and other features.

The surface soils, to a depth of about 10 inches, consist of gray sandy material that is loose and incoherent. The subsoils are pale yellowish gray to grayish yellow, becoming yellow when moist but light gray when dry. They break into somewhat cloddy material that pulverizes very easily. Like the surface soils, the subsoils are of sandy texture. They are underlain by a gray coarse-textured sandstone at a depth ranging from 1 to 6 feet below the surface. The soils of this series are extremely variable in texture, owing to erosion. All horizons are distinctly acid, having a pH value below 5.0. In

this feature as well as in the gray color they differ from the soils of the Altamont series. Small areas of Arnold soils were included with the Altamont soils in the reconnaissance soil survey of the San Francisco Bay region (*6*), although the Altamont soils are now recognized as properly confined to areas of lower rainfall and neutral or mildly alkaline soils.

Arnold sand.—Arnold sand is dark-gray to gray sand to a depth of about 10 inches, becoming dark brownish gray when moist and light gray when dry. This material is somewhat coherent when moist and incoherent when dry. It is medium to strongly acid, having a pH value of about 5.0 to 5.7. The subsoil, which extends to a depth of 40 inches, is pale grayish-yellow sand that is only slightly coherent when moist and is gray when dry. It is strongly acid, with a pH value of about 4.6. It is underlain by brownish-gray to yellowish-gray partly disintegrated coarse-grained sandstone. The depth to the sandstone ranges from 24 to 60 or more inches.

Arnold sand is developed on the rather flat tops of ridges having a slope ranging from about 5 to 15 percent. It is a porous soil of low fertility. The largest areas are in the northwestern part of the area, near Bonnie Doon, and northeast and southeast of Mount Hermon. Probably 20 percent of the land has been cleared and is used for growing grapes, apples, and some garden crops. The grapevines and trees appear stunted, and yields are very low.

Arnold sand, steep phase.—To a depth of about 10 inches, the surface soil of Arnold sand, steep phase, is gray coarse sand, that is dark brownish gray when moist and light gray when dry. This passes into yellowish-gray coarse sand containing much rotten sandstone, the quantity of sandstone increasing with depth. The soil rests on the parent material, consisting of pale yellowish-gray coarse rotten sandstone, at an average depth of about 20 inches. The depth to the sandstone varies greatly, owing to the steep relief, and outcrops and ledges of rock are numerous. Sand has accumulated to a depth of 10 feet or more at the foot of slopes. This soil has a choppy mountainous relief, and slopes range from 25 to 50 percent or more.

Wind erosion has cut the land into a choppy serrated slope in places. Most of this soil occurs in areas near Mount Hermon. It is not extensive.

This is a porous, infertile soil of little agricultural value. Practically none of the land is cultivated, but some of it is used for chicken farms. Many summer homes have been built on this soil, as the sand makes a good playground. Much commercial sand used in making plaster is quarried on areas of this soil. The vegetative cover consists of a few scattered scrubby ponderosa pine, scrubby oaks, some manzanita, and brush and ferns in the open places.

HOLLAND SERIES

The surface soils of members of the Holland series under virgin conditions are covered with a thin layer of litter, below which the soil, to a depth of 10 to 20 inches, is brown or grayish-brown micaceous friable material that has a soft cloddy structure and breaks easily in the fingers. This material contains sharp angular quartz fragments and is highly porous. Roots and moisture penetrate it readily. The surface soils have a low to medium content of organic matter, have

fair water-holding capacity, and are strongly acid. The subsoils, to a depth ranging from 35 to 45 inches, are brown to rich-brown micaceous slightly to moderately compact loam, which dries out rather hard and breaks into angular fragments. The subsoils contain sharp angular quartz grit, and the worm and root channels are coated with colloidal clay. This somewhat compact material is sufficiently porous to allow good penetration of moisture and roots. The reaction is strongly acid. The subsoils rest on soft disintegrating strongly acid quartz diorite that is permeable to moisture and roots to a depth of several feet.

The Holland soils in this area are developed in place on quartz diorite rock. They are closely associated with soils of the Sheridan series, the principal difference being the lighter color of the surface soils of the Holland series. They occupy smooth but in many places steep slopes and gently rolling ridge tops on Ben Lomond Mountain. They support a good growth of native forest, principally redwood, fir, tanbark oak, coast live oak, and madrone. Many burned-over areas support dense growths of brush, manzanita, and fourwing saltbush (chamiso). The cleared areas are subject to rather severe erosion. Agriculturally considered, these soils are not very important in this area.

Holland sandy loam.—Under virgin conditions, the surface soil of Holland sandy loam is covered with a 1- to 2-inch layer of forest litter. The 10- to 20-inch surface soil is brown or grayish-brown micaceous gritty friable sandy loam that is easily tilled. It is somewhat low in organic matter, strongly acid, and medium to low in fertility. The water-holding capacity is rather low. This layer rests on a slightly heavier textured layer of light-brown micaceous gritty loam that also is strongly acid and somewhat compact, although readily permeable to moisture and roots, and that contains some worm and root channels. At a depth of 35 to 45 inches it grades into weathered granitic material that is rather soft and strongly acid. This material extends to a depth of several feet before the hard consolidated bedrock is reached.

This soil has a smooth surface with gentle to moderately steep slopes. In places where the land is cleared, erosion is rather active and surface runoff is rapid. Both surface soil and subsoil drainage are excellent.

Under virgin conditions this soil supported a fairly good stand of timber, principally redwood, Douglas-fir, oak, and madrone; but no virgin stands of timber remain at present. In some areas, where burning has been severe, the principal cover is brush, mostly manzanita and fourwing saltbush (chamiso).

Holland sandy loam occurs along the eastern slopes of Ben Lomond Mountain and on the southern end of that mountain northeast of Santa Cruz.

The cleared areas of this soil are used mostly for deciduous fruits, grapes, pasture, and grain hay. Most of the orchards are old, many trees are missing, erosion has been severe, and production is very low. No irrigation water is available; summer temperatures are high; and, although the annual rainfall is high, the dry season extends over most of the growing period of deciduous fruits. In many places orchards and vineyards are being abandoned and the land is reverting to brush. This soil, together with its phases, is a potential timber-producing soil.

Holland sandy loam, steep phase.—Holland sandy loam, steep phase, is similar in profile to typical Holland sandy loam, except that it is more variable in depth. The slope is very steep, in most places being more than 25 percent and prohibitive of agricultural use. A few small areas of this steep soil have been cleared, but erosion has been excessive and the land has proved so difficult to work that it was soon abandoned. Fairly good stands of timber are growing on the steep slopes.

Holland fine sandy loam.—Under virgin conditions, Holland fine sandy loam is covered with a forest mulch or litter, from ½ to 1½ inches thick. The surface soil, to a depth of 10 to 20 inches, is brown or grayish-brown micaceous fine sandy loam containing sharp angular quartz fragments that give the soil a gritty feel. The material is soft and friable, working to a good granular tilth. Under cultivation, the color is generally rich brown rather than grayish brown. The upper subsoil layer, which reaches to a depth of 20 to 30 inches, is a little lighter colored than the surface soil. It is slightly compact yet friable micaceous loam. The lower subsoil layer is yellowish-brown somewhat compact heavy loam that dries out rather hard and breaks into angular fragments. It rests on disintegrating quartz diorite bedrock that is soft and permeable to water and roots. This material extends downward for some distance before reaching consolidated bedrock.

The reaction is medium to strongly acid throughout. The surface soil has a rather low to medium content of organic matter. In general, the fertility and water-holding capacity are low to medium, and surface and subsoil drainage are good. The soil occupies smooth but gentle to moderately steep slopes. When the land is cleared, runoff is high and erosion is rather severe.

This soil occurs on Ben Lomond Mountain northwest of Bonnie Doon and in the southern part of that mountain northwest of Santa Cruz.

Under natural conditions the land is forested with redwood, fir, oak, and madrone. The cleared areas are used for apples, prunes, grapes, and pasture. The orchards and vineyards are spotted, many trees and vines are missing, and a number of orchards have been abandoned, although there are a few well-kept fairly productive orchards. Lack of irrigation water limits the use of this soil for agriculture. Although a small part of the land is being cleared for farming at present, probably a greater part is being abandoned or the orchards are neglected and the land is reverting to a brush cover, so that the acreage under cultivation is diminishing.

Included with mapped areas of Holland fine sandy loam is a small body northeast of Bonnie Doon that is much redder than typical Holland soil but otherwise practically the same. If this soil were more extensive, it would be differentiated as a distinct soil type.

Holland fine sandy loam, steep phase.—The steep phase of Holland fine sandy loam is almost identical with that of typical Holland fine sandy loam, except for the greater range in depth. The slopes are very steep, which makes the land worthless for agriculture because of severe erosion when the native cover is removed, but it supports good stands of timber in uncleared areas. Only 64 acres of this soil are mapped.

SHERIDAN SERIES

Under native conditions the surface soils of members of the Sheridan series are covered by a 1- to 3-inch layer of leafmold or forest litter. The soil below the leafmold, to a depth ranging from 1½ to 3 feet, is dark brownish-gray micaceous loose and friable granular material moderately high in organic matter. Under cultivation the surface soils, although still very dark, are considerably lighter colored than under virgin conditions. This difference in color is greater in the lighter textured members. The surface soils are very permeable to roots and moisture, are medium to strongly acid, and contain a considerable quantity of sharp angular quartz fragments, which give the soil material a very gritty feel. The subsoils, to a depth ranging from 2 to 5 feet, are brown or dull-brown micaceous slightly compact materials that are slightly heavier textured than the surface soils. They are medium to strongly acid and have a somewhat cloddy structure. When dry the clods are rather angular, but they break easily under pressure. This layer is readily penetrated by moisture and roots. The substratum is medium to strongly acid disintegrating quartz diorite that is loose and permeable to a considerable depth.

The Sheridan soils are residual soils developed on granitic rocks. In this area the parent material is entirely quartz diorite. These soils occupy smooth sloping ridge tops and steep hillsides on Ben Lomond Mountain. When the land is cleared, erosion is severe and surface runoff is excessive, although both the surface soils and the subsoils afford good drainage.

Under native conditions these soils support a good growth of trees, mainly coast live oak, redwood, tanbark oak, and madrone. They are closely associated with soils of the Holland series, differing mainly in the darker color of the surface soils. These soils are of medium to low fertility, rather variable in depth, and agriculturally rather unimportant. They were included with the related soils of the Holland series in the earlier, less detailed reconnaissance survey of the San Francisco Bay region (*6*).

Sheridan sandy loam.—Under forest, Sheridan sandy loam has a layer of leafmold about 2 inches thick covering the surface soil, which, to a depth ranging from 18 to 36 inches, is dark brownish-gray micaceous sandy loam containing sharp angular quartz fragments, which give the soil a gritty feel. The surface soil is somewhat high in organic matter, loose, friable, readily penetrated by roots and moisture, and medium to strongly acid. It is not sticky, even when wet, and although soft granular lumps may form, they break up very readily. Under cultivation the soil is not quite so dark as under virgin conditions. The next lower layer consists of slightly heavier sandy loam, high in mica, strongly acid, and slightly cloddy, the clods being easily broken. At a depth of 3 to 5 feet this rests on disintegrating bedrock that is loose and soft to a depth of several feet.

The depth of the soil is variable. In places rocks or boulders lie on the surface, and a few feet away the soil is several feet thick. In most places, however, where the bedrock is covered with soil, the underlying layer of disintegrating bedrock is several feet thick. This soil does not have a very high water-holding capacity, and drainage

is good to excessive in both the surface soil and the subsoil. It occurs in the northern part of Ben Lomond Mountain from Eagle Rock southward.

The surface is smooth but somewhat sloping. The principal occurrence of this soil is on the ridge tops and the steeper slopes of the canyons and ravines. Where cleared, the surface soil erodes badly and surface runoff is excessive.

Most of this soil is forested, but a few areas are planted to grapes and tree fruits or are in pasture. Although the vineyards produce from 1 to 2 tons of grapes an acre, nearly all of the orchards have been abandoned. Lack of water for irrigation is probably the principal reason for the failure of fruit trees on this soil.

Sheridan sandy loam, steep phase.—Sheridan sandy loam, steep phase, differs from typical Sheridan sandy loam principally in the steepness of the slopes. As the slopes are steeper than 25 percent, this soil should never be used for cultivated crops. Good growths of timber are on these steep slopes, but when cleared the soil erodes severely and the land must soon be abandoned.

Sheridan loam.—Under virgin conditions, the surface soil of Sheridan loam is covered with a 1- to 3-inch layer of leafmold or forest litter. Below this, to a depth of 15 to 36 inches, the soil material consists of dark grayish-brown or dark brownish-gray micaceous loose and friable granular medium to strongly acid loam, which is moderately high in organic matter, very permeable to roots and moisture, and does not dry out hard. It contains numerous sharp angular quartz fragments, which give it a gritty feel. The subsoil, to a depth ranging from 2 to 4 feet, is dull-brown micaceous loam, somewhat compact, yet easily penetrated by roots and moisture. This material is slightly heavier textured than that above. It dries out rather hard, and the fragments break into rather angular aggregates. The reaction is strongly acid. The subsoil rests directly on disintegrating granitic material that is rather soft to a depth of several feet.

This soil seems to be rather fertile, but it has a rather low water-retaining capacity despite its rather high organic-matter content. Both surface and subsoil drainage are good to excessive. This soil occupies rather smooth sloping ridge tops and steeper sloping hillsides. These ridges are cut by deep canyons and steep ravines on which the steep phase of Sheridan loam is mapped. Nearly all of this soil is in the northern and western parts of Ben Lomond Mountain, although one or two areas occur near the southern end.

Not many areas are cleared, as cleared areas erode rather severely. Grapes and deciduous fruits, in addition to pastures are the principal crops grown on this soil. Most of the orchards are old, many trees are missing, and few are being replaced, thus leaving the orchards in a low state of productivity, which soon leads to abandonment.

The native vegetation on this soil consists of redwood, coast live oak, tanbark oak, Douglas-fir, and madrone. Burned-over or abandoned areas are rapidly growing up to brush, principally poison-oak, scrub oak, and manzanita. Fairly good pasture is growing on the cleared areas, but brush is rapidly gaining a foothold in them. Vineyards that are well cared for and are not on too steep slopes can

be kept in a fairly good state of productivity. Agriculturally, this soil is comparatively unimportant, although it has some potential value for producing timber.

Sheridan loam, steep phase.—The steep phase of Sheridan loam, like the steep phase of Sheridan sandy loam, differs from its typical soil mainly in the steepness of the slopes. The slopes are so steep that the soil is wholly unsuited to farming, but it is capable of producing good stands of trees. Wherever the land is cleared or burned over, erosion is very active.

FELTON SERIES

The members of the Felton series are developed in place on weathered highly metamorphosed quartz and mica schist. They are formed under an annual rainfall ranging from 40 to 60 inches. These soils occupy smooth ridge tops having moderate to steep slopes.

Both surface and subsurface drainage are well developed. Surface runoff is very rapid on the steeper areas, particularly where the land supports little vegetation. Most of the soils of this series, however, are uncleared, and surface runoff and erosion are slight.

Under virgin conditions the areas of deeper soil support fair to good stands of redwood, Douglas-fir, coast live oak, and madrone, and the areas of shallower soil are covered with brush, manzanita, fourwing saltbush (chamiso), and knob-cone pine. Very few of the knobcone pine trees grow larger than 6 or 8 inches in diameter.

The surface soils of members of the Felton series, to a depth ranging from 3 to 18 inches, are brown to reddish brown, sandy, loose, friable, granular, high in mica, and medium to strongly acid. These soils are permeable to moisture and plant roots, and they have a low to medium content of organic matter. When wet they are distinctly redder than when dry. The subsoils, which extend to a depth ranging from 15 to 40 inches, are bright yellowish brown or reddish brown, becoming distinctly redder when wet. The subsoils are only slightly to moderately compact, although they are heavier textured than the surface soils. They are micaceous and break to a distinctly cloddy structure. The clods are rather hard when dry, but the subsoils are permeable to roots and moisture. The subsoils, like the surface soils, are strongly acid in reaction. Bedrock consists of disintegrating mica schist, that is highly metamorphosed and in many places contains considerable quartz or quartzite.

Felton loam.—Under virgin conditions the surface soil of Felton loam is covered with a thin layer of forest litter. Below this the surface soil, extending to a depth of 12 to 18 inches, is a brown loose and friable granular micaceous loam that is very permeable to roots and moisture, has a medium to low content of organic matter, and is medium to strongly acid. This layer is underlain by yellowish-brown to reddish-brown slightly compact micaceous clay loam that dries out rather hard and breaks into angular fragments. It is permeated with worm holes and root channels that have colloidal coatings and is very pervious to moisture, allowing free drainage. This layer rests, at a depth ranging from 24 to 45 inches, on a soft disintegrating mica schist bedrock. The entire soil mass is medium to strongly acid, and the soil is medium to low in fertility. In most places the soil

is not more than 30 to 36 inches thick and has only medium to low water-retaining capacity.

This soil occupies the broad ridge tops and smooth sloping hillsides in the southern part of Ben Lomond Mountain. It supports a fair growth of redwood, Douglas-fir, oak, and madrone. This is the only member of the Felton series that is used for agriculture, but even this soil with the exception of a very few areas, is limited to pasture.

The lack of irrigation water and the rather shallow soil necessarily limit the agricultural value of this land. It is fairly good potential timberland.

Felton loam, steep phase.—This soil is similar in profile to typical Felton loam, but it occupies the steep eastern slopes of Ben Lomond Mountain and the steep slopes of canyons and ravines that cut into the mountain. None of the steep slopes has been cleared, and the land supports a fair forest growth, which is all second growth, as all the virgin timber has been removed.

Felton stony sandy loam.—Felton stony sandy loam, to a depth ranging from 2 to 8 inches, is brown or reddish-brown stony or gravelly loose granular sandy loam that is distinctly redder when wet. It is strongly acid. This is underlain by a layer of reddish-brown or brownish-red granular friable stony or gravelly clay loam that is strongly acid and permeable to roots and water. At a depth of 15 to 24 inches this material rests on disintegrating mica schist parent bedrock.

This soil is shallow and stony, is low in fertility, and has no agricultural use. It is covered with a growth of brush and scattered knob-cone pines. Surface drainage is excessive, but erosion is not active. The soil occurs on the ridge tops in the southern part of Ben Lomond Mountain and is not very extensive.

MORO COJO SERIES

The Moro Cojo series includes soils that have brown, light reddish-brown, or, in a few places, grayish-brown surface soils. The subsoils generally are somewhat more pronounced red or yellow than the surface soils, are rather compact, and yet contain considerable sand. The surface soils are friable when moist but become somewhat harder when dry. Even where sandy, the subsoils contain sufficient colloidal accumulation to make them hard when dry. They contain brown rounded concretions or nodules of iron-cemented sandstonelike character. In some flat areas the subsoils are reddish-brown compact sandy clay loam, whereas on the slopes they are lighter textured and less compact. The substrata, or parent materials, vary considerably in the degree of consolidation from unconsolidated sandy material to semiconsolidated sandstone. The entire soil mass is acid, with a pH value ranging from about 5.5 in the surface soils to 4.5 or 5.0 in the lower subsoil layers and substrata.

The Moro Cojo soils occupy rolling to fairly steep slopes at elevations between 200 and 400 feet above sea level. These soils have been modified to a considerable extent by erosion, so that the kind of profile occurring on the tops of ridges differs considerably from that on the slopes. On the crests of the ridges reddish-brown consolidated sandstonelike material outcrops in many places, whereas on

many of the lower slopes the soil mantle is deeper than typical. The Moro Cojo soils are developed in place on reddish-brown soft sandstonelike coastal-terrace materials. They support a low brush cover and a few small coast live oaks. When the cover is removed the soils erode very badly.

Moro Cojo loamy sand.—The surface soil of Moro Cojo loamy sand consists of brown friable loamy sand, to a depth of 12 to 24 inches, where it grades into light reddish-brown moderately compact gritty loam. Throughout this layer iron-cemented pellets are present in places. The subsoil rests on brown to yellowish-brown soft sandstonelike material at a depth ranging from 20 to 40 inches below the surface. This soil occupies rolling to fairly steep slopes and to a considerable extent has been modified by erosion. It is developed in place on semiconsolidated sedimentary coastal-plain deposits. On the crests of some of the ridges reddish-brown consolidated or cemented sandstonelike capping or outcroppings are present. As a rule this soil is deeper on the lower slopes and fairly shallow on the tops of the ridges.

Moro Cojo loamy sand occurs along the extreme southern boundary, along the coast as far north as Aptos, and thence inland to Oakdale and Browns Schools. The largest body is on the southern boundary and joins with the Moro Cojo soils as mapped in the Salinas area to the south (*4*).

The vegetation on Moro Cojo loamy sand is mostly coast live oak and various shrubs. At present, from about 10 to 15 percent of the soil is cleared for cultivation. The main use is for apricot and apple orchards, although grain, grapes, and truck crops are grown to some extent. Yields of apples on this soil are very low compared with those obtained on the fertile soils of the lower flat valley lands. Yellow Newtown apples produce from 75 to 300 boxes an acre, and Yellow Bellflower apples from 100 to 350 boxes.

Moro Cojo loamy sand is low in fertility and is very acid throughout, the pH value ranging from 5.0 in the surface soil to 4.5 in the subsoil. These features, together with its rather low water-holding capacity and high erodibility, greatly lower the agricultural value of the soil. As this soil is subject to erosion, great care should be taken in the cultural practices used.

Moro Cojo sandy loam.—The surface soil of Moro Cojo sandy loam consists typically of brown friable sandy loam to a depth of approximately 16 or 18 inches, where it is underlain by an upper subsoil layer of light reddish-brown slightly compact sandy loam. At a depth of about 45 inches the lower subsoil layer is reached. This is brown moderately compact gritty loam. A few iron concretions of irregular outline and ranging in size from peas to marbles occur in places throughout the subsoil. At a depth of about 60 inches the soil material passes into a substratum of mottled loosely consolidated sandy marine sediments. Moro Cojo sandy loam is developed on tops of ridges and borders areas of Moro Cojo loamy sand. It has developed on old marine terraces of soft semiconsolidated sandstonelike character. Drainage is good, but erosion is very active on this soil and in some places has modified the soil profile considerably.

This soil is easily tilled, but its sandy texture and low organic-

matter content provide only a fair water-holding capacity. The soil material is acid throughout, having a pH value of 5.5 in the surface soil and 4.5 in the subsoil.

Moro Cojo sandy loam occurs near the coast about 7 miles north and northwest of Watsonville. One body is just east of Manresa; smaller bodies are scattered in the vicinities of Larkin Valley and Oakdale School.

Comparatively little of this soil is cleared for cultivation. The native vegetation is coast live oak and various shrubs. Moro Cojo sandy loam is used for apples and general truck farming. Its general agricultural value is lowered by its low fertility and ease of erosion. Apple yields on this soil are low compared with the yields on some of the more fertile valley soils, such as the Botella and the Soquel.

In this survey, Moro Cojo sandy loam includes two rather distinct but inextensive and rather unimportant variations. One of these is represented by small areas in which the surface soil is darker colored than typical and has a somewhat higher organic-matter content. Here, the surface soil is grayish-brown sandy loam to a depth of 16 or 18 inches, where it is underlain by a slightly darker moderately compact sandy loam or loam subsoil. The substratum of soft semiconsolidated sandstone lies at a depth of 26 to 30 inches. This inclusion is subject to erosion and has an acid reaction throughout. It occurs only in three small bodies near Browns School and a fourth body near San Andres School. Most of this soil adjoins Moro Cojo loamy sand or Moro Cojo sandy loam on the north slopes. At present none of it is under cultivation. The native vegetation is the same as on the typical areas.

The other inclusion consists of a number of small bodies of Moro Cojo sandy loam in which the soil is of heavier loam texture. These areas are 1⅛ miles northwest of Aromas, 1¼ miles north of Casserly School, 1 mile northwest of Pleasant Valley School, and 1½ miles south of Larkin Valley School. If the total area of this variation were larger, it would be classified separately as Moro Cojo loam. Because of its heavier texture, it has a higher moisture-holding capacity than typical Moro Cojo sandy loam, but the land is used in about the same way.

Moro Cojo gravelly loam.—The surface soil of Moro Cojo gravelly loam consists of dull-brown gravelly loam to a depth of 12 or 15 inches, where it is underlain by the subsoil of light-brown moderately compact sandy clay loam. At a depth of approximately 25 to 30 inches the soil material grades into a substratum consisting of a light yellowish-brown unconsolidated or softly consolidated mass of sand and gravel. This soil, in common with the other soils of the Moro Cojo series, is formed on semiconsolidated marine sediments. Drainage is good, but the water-holding capacity is only fair.

This soil occupies rolling to moderately steep slopes at an elevation ranging from 200 to 300 feet. Erosion is active, and any cultural practices must be carried on with extreme care to avoid soil washing. This soil is acid in both the surface soil and the subsoil.

As mapped in the Santa Cruz area, Moro Cojo gravelly loam includes small areas of soil of either slightly heavier or lighter texture

than the typical soil. Three bodies of such soil are near Browns School, two are near Hill and Green Valley Schools, and three are near Pleasant Valley School. One small included area of sandy loam texture is a mile northwest of Hill School and a small body of gravelly clay loam texture is near Bear Valley.

Typical areas of Moro Cojo gravelly loam are just west of Ferndale School, and in the upper end of Pleasant Valley near Pleasant Valley School.

The native vegetation on this soil is mainly coast live oak and various small shrubs. At present about 30 percent of the land is under cultivation. Apples are the main crop, and a small quantity of apricots is grown. Yields of apples on this soil are low, only 75 to 250 boxes an acre being obtained. The gravelly substratum, with the consequent low moisture-holding capacity, and rather high acidity, lowers the agricultural value of this soil.

A number of small bodies of Moro Cojo gravelly loam differ from the typical soil in that they have a gravelly sandy surface soil and a coarser textured subsoil. These areas are one-half mile east of Corralitos and 1 mile west of Ferndale School. If this included material were more extensive it would be classified as Moro Cojo gravelly sand. It is not well adapted to agriculture because of its low water-holding capacity, low fertility, and eroded surface soil.

TIERRA SERIES

The surface soils of members of the Tierra series are dark dull grayish brown or dark brownish gray. They are underlain abruptly by brownish-gray or dark grayish-brown compact plastic sandy clay subsoils that normally are capped by a light-gray siliceous sandy loam layer 1 or 2 inches thick. The topmost part of the sandy clay layer breaks to a prismatic or columnar structure, the prisms having a heavy glazing of dark-colored colloidal material. The lower subsoil layer is lighter gray than the upper subsoil layer, compact, and highly mottled with yellow and brown stains. When dry the material breaks into hard cubical blocks. The parent materials are semiconsolidated marine sediments consisting of brownish-gray or yellowish-gray sandy clay loam or sandy clay. The reaction is acid throughout. The pH value ranges from 5.0 to 5.6.

The Tierra soils occupy high eroded marine terraces. They have strongly developed profiles and support a natural brush cover. Surface drainage is rapid in most places, but subdrainage is retarded by the heavy clay subsoils. Roots normally do not penetrate the clay subsoils. Erosion is very active once a gully is started.

Tierra loam.—The 6- to 10-inch surface layer of typical Tierra loam consists of very dark dull grayish-brown friable granular loam well filled with roots and easily penetrated by water. The subsurface layer, which continues to a depth of 12 to 24 inches, consists of material that is similar in texture and in color to that above, but it is somewhat compact, breaking into rather blocky aggregates. These aggregates become very hard on drying, but they are easily broken at the proper moisture content. Below this is a 1- to 3-inch layer of ashy vesicular siliceous material that has a sharp, harsh, sandy feel and is mottled with dark-brown stains. This layer rests abruptly on very compact dull brownish-gray clay or sandy clay. The upper

3 to 6 inches of this layer is columnar when dry, and the tops of the columns are rounded, giving them a biscuitlike appearance. The columns are heavily coated with dark-colored colloidal material, indicating that, on drying, the columns persist and that the cracks between them are the lines of cleavage where the cracks occur season after season. Below the columns the color is somewhat lighter and the material breaks into prismatic blocks that are very compact, hard, and difficult to break but are very sticky when wet. The substratum, to a depth of more than 6 feet, is yellowish-gray compact clay or sandy clay.

The entire soil mass is medium to strongly acid throughout. Surface drainage is adequate, but the compact clay subsoil is almost wholly impervious to roots and water. This soil erodes badly, and many deep steep-sided gullies occur where the slope is steep.

This soil, together with other soils of the Tierra series, occurs in small somewhat scattered areas on high marine terraces. A few bodies are north of Santa Cruz, but most of the areas are between Aptos and the southern end of the area.

This soil is of low agricultural value. Because of the very compact subsoil, only shallow-rooted plants are adapted. The soil is rather low in plant nutrients, has been strongly leached, and is so highly erodible that it cannot safely be cleanly cultivated; consequently about its only use is for pasture.

As occurring in this area, Tierra loam includes variations of browner color than typical in which the surface soil is grayish-brown to brownish-gray slightly cloddy but friable loam to a depth of 6 to 10 inches, where it is underlain by a slightly more compact layer of the same color and texture. This layer extends to a depth of 15 to 24 inches. The deeper part of this included soil is essentially similar to typical Tierra loam. The soil is normally acid throughout the profile, but in the vicinity of Davenport, where it is most extensive, the surface soil is slightly acid or calcareous in places. This condition is caused by the calcareous dusts from the cement plant at Davenport. Some grass hay and a few beans are grown, but the soil returns low yields. Most of the land is used for pasture. Nearly all areas of this variation of Tierra loam occur on rather flat terraces, extending from Santa Cruz northwestward on the high marine terraces lying 1 or 2 miles inland from the coast. These areas do not erode so badly as do those of typical Tierra loam. Two areas of this included soil west of Corralitos are more like typical Tierra loam in sequence of layers, the principal difference being in the color of the surface soil.

Tierra clay loam.—The surface layer of Tierra clay loam, to a depth of 6 to 12 inches, is a dull dark grayish-brown rather granular and friable clay loam. The lower part of the surface soil, which reaches to a depth of 12 to 18 inches, is dark dull brownish-gray moderately compact cloddy clay loam. Below this is a 1- or 2-inch layer of light-gray vesicular sandy loam or loam. The subsoil, to a depth ranging from 32 to 45 inches, is dull grayish-brown very compact sandy clay. The upper part of this layer is slightly darker and has a definitely columnar structure. The columns are coated with colloidal material. The lower part breaks into prismatic blocks with sharp angular corners and has colloidal coatings on the surface

of the blocks. Below this layer is a layer of massive blocky sandy clay loam highly mottled with iron stains in the upper part, the mottlings decreasing with depth. The layer extends to a depth of 5 to 6 feet.

This soil occupies the slopes of old eroded terraces. It gullies badly, and, owing to the extremely impervious subsoil, it is suitable only for shallow-rooted crops. The surface soil is fairly permeable to roots and water, but, because of the sloping surface, runoff is excessive. About the only agricultural use for this soil is pasture. Its original cover was native grasses and brush. It occurs in about the same general areas as Tierra loam.

CORRALITOS SERIES

The Corralitos soils consist of outwash materials having their source in sedimentary rocks, particularly the rocks that give rise to the Moro Cojo and Hugo soils. The sandy-textured soils come from the Moro Cojo and the finer textured soils from the Hugo outwash. These soils are recent alluvial deposits occupying sloping confluent alluvial fans and showing no evidence of the development of a profile. They occur under high rainfall and are acid in reaction, which characteristic is inherited from the parent material. These soils occupy smooth slopes and hollows cut by channels on the steeper sandy alluvial fans. Runoff is fairly rapid on the steeper fans and somewhat slow on the flatter areas. Subdrainage is generally good. The native vegetation consists of trees, brush, and grass. Nearly all of the native cover has been removed, and the soils are now in crops.

The soil profile shows very little difference to a depth of 6 feet or more, except for differences in texture, owing to stratification of parent materials. The surface soils are brown or light brown, porous, and without any characteristic structural arrangement. The subsoils and substrata are generally somewhat lighter colored than the surface soils. They are loose, porous, and similar in most respects to the surface soils. The entire soil mass is acid in reaction, in most places having a pH value between 4.5 and 5.5. This is the chief characteristic that sets these soils apart from the related Yolo soils, which typically are neutral or nearly so.

Corralitos sand.—The 10- to 14-inch surface soil of Corralitos sand consists of medium light-brown to brown sand having a single-grain condition. This sand grades into light-brown or light yellowish-brown loose or friable sand of variable depth. It represents recent sandy deposits from eroded sedimentary rock sources, mainly materials of the Moro Cojo and the Hugo soils.

The extreme permeability of this soil makes its water-holding capacity very low. The soil is also low in organic matter and plant nutrients. It is acid throughout, having a pH value ranging from 5.0 in the surface soil to 5.9 in the subsoil. These factors combine to make its agricultural value fairly low, although the addition of fertilizer will give fair crop returns.

The surface erodes easily, but erosion is not noticeable, owing to deposition of material from the higher slopes. This soil occurs as local stream outwash and alluvial fans at the base of eroding slopes.

Bodies of Corralitos sand are scattered throughout the area east and northeast of Aptos and north of Watsonville. Most of them are

small, lying in the bottoms of draws that extend back into the rougher country and at the base of slopes occupied by soils of the Moro Cojo and the lighter textured soils of the Hugo series.

Grasses, redwood, tanbark oak, and associated vegetation predominated in the native cover, but at present only a very small proportion of the land remains uncultivated. By far the larger part is planted to apple orchards, especially in the areas at the foot of the hills. Pears, some apricots, and some cherries are grown. Cherries seem to give the best yields when planted in the lower moist areas, but they do not thrive in excessively wet depressions. The extreme friability throughout this soil makes it well suited to such deep-rooted crops rather than to shallow-rooted crops, which are more likely to suffer from drought.

Corralitos sand, shallow phase (over Botella soil material).—A few small areas are mapped where a shallow layer of Corralitos sand has been deposited over buried Botella soil material, which can be reached with a 42-inch soil auger, although the depth to the buried soil differs greatly from place to place. The surface layer is identical with that of typical Corralitos sand. This soil occurs only in small creek bottoms, such as that northwest of Aromas. Its agricultural use does not differ markedly from that of typical Corralitos sand.

Corralitos sandy loam.—Corralitos sandy loam, to a depth of about 18 inches, is light-brown friable sandy loam. This material continues downward with no change except a very slightly lighter brown color. It is very permeable, contains a moderate quantity of organic matter, and is strongly acid (pH value 4.7 to 5.7). It has a high water-absorbing capacity, does not erode badly, and does not receive excessive depositions that change the texture of its surface soil from year to year. It occupies small stream bottoms and is stratified to some extent.

The largest area of this soil is northeast of Watsonville; others are near Felton and elsewhere. Owing to their very small extent, two small bodies of loam texture are included with Corralitos sandy loam as mapped; one is in the northwestern corner of the county on Waddell Creek, and one is at Mountain School.

Redwood formerly dominated the native vegetation on all these areas, and on many of them it still does. The very small size of the individual bodies and their scattered location prevent important economic use of the land, but it supports a few small productive apple orchards.

METZ SERIES

The Metz series includes recent alluvial soils that have been derived from sedimentary and acid igneous rocks. The parent materials have been transported from regions of fairly low rainfall, in this area mainly from the drier part of San Benito County. These soils occupy level flood plains and in places are subject to overflow. Aside from occasional overflows, drainage conditions are good. Originally the native cover consisted of brush, willow, sycamore, and some grass along the stream channels. Practically all of the soils of this series have been cleared and are used for tilled crops at present.

The surface soils range in color from light brownish gray to light grayish brown. They are calcareous, low in organic matter, and extremely friable and contain considerable fine-grained mica. Charac-

teristically they exhibit no particular structural arrangement or development of a profile. The subsoils are very similar to the surface soils, and the profile is modified only by some stratification. Some building up of the soil material may take place by deposition during floods.

Metz fine sandy loam.—The surface soil of typical Metz fine sandy loam consists of grayish-brown calcareous finely micaceous fine sandy loam. At a depth ranging from 10 to 13 inches it grades into a subsoil of light grayish-brown calcareous stratified materials.

Metz fine sandy loam, formed by flood-plain deposits of the Pajaro River, occupies smooth gently sloping first bottoms adjacent to the river. The soil is subject to occasional overflow during periods of heavy rainfall, and this hazard tends to lower its agricultural value somewhat.

This soil is friable and easy to till. Its loose structure makes it easily penetrable by water and plant roots and generally favorable for the production of crops. The above factors tend also to give it excellent drainage. Erosion is nonexistent, but deposition of fresh alluvial material occurs at each overflow of the river.

In this area, Metz fine sandy loam includes a few small areas of soils that are lighter textured than the typical soil and that would be recognized as Metz loamy fine sand and Metz fine sand if they were more extensive. The small areas of loamy fine sand texture are southwest of Watsonville, one at the extreme western end of the Pajaro Valley near the outlet of the river, one near Beach School, and a third on the southwestern edge of Watsonville. The areas of fine sand texture have a somewhat coarser textured subsoil than the other Metz soils. They occur only in two small areas along the Pajaro River, one 3½ and the other 6 miles east of Watsonville. Owing to the coarser texture, penetration of moisture is rapid and internal drainage is somewhat excessive. These areas have a lower moisture-holding capacity and consequently lower value than typical Metz fine sandy loam.

The native vegetation on Metz fine sandy loam consisted of willows and herbaceous plants, but now all the land is cleared and under cultivation. It is used for the production of apples, lettuce, beans, tomatoes, sugar beets, and general truck crops. Owing to the danger of overflow, the soil is mostly used for summer crops, such as sugar beets, lettuce, tomatoes, and beans, and high yields are obtained. Where protected from overflow, Metz fine sandy loam is a good soil well adapted to general truck crops and orchards.

Table 5 gives the results of mechanical analyses of samples of two layers of Metz fine sandy loam.

TABLE 5.—*Mechanical analyses of two samples of Metz fine sandy loam in the Santa Cruz area, Calif.*

Sample No.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
	Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
578801	0-12	0 1	1 0	4 1	35 8	26 1	24 5	8 4
578802	12-72	0	3	1 7	19 2	36 7	35 3	6.8

Metz fine sandy loam, shallow phase (over Salinas soil material).—This soil has a surface layer of grayish-brown micaceous calcareous fine sandy loam typical of the soils of the Metz series, overlying an unrelated Salinas soil. It is a distinct overwash, as the change to the underlying Salinas soil is abrupt at a depth of 20 to 40 inches. The underlying soil consists of dull grayish-brown to brownish-gray noncalcareous clay loam or silty clay loam, which extends to a depth of about 40 inches, where it grades into a slightly compact heavier textured calcareous substratum. Soil of this phase has the smooth and gently sloping relief of the Metz soils.

The Salinas subsoil increases the water-holding capacity over that of typical Metz fine sandy loam, but it may somewhat retard internal drainage. The soil is easily tilled and responds well to irrigation and cultural practices. This soil is not subject to erosion.

This phase of Metz fine sandy loam occurs only in the western end of the Pajaro Valley. Four bodies are near the Pajaro River about 1½ miles southwest of Watsonville. All the land is under cultivation, and high yields are obtained. Almost all of it is used for lettuce and general truck crops. The excellent water-holding capacity makes this a good soil for growing lettuce, and it is adaptable also to general agricultural use.

Metz silt loam.—The surface soil of Metz silt loam, to a depth of 12 to 16 inches, consists of light-brown or grayish-brown mellow calcareous silt loam. The subsoil, to a depth of 72 inches, consists of grayish-brown calcareous variably textured stratified sediments. This soil, in common with other Metz soils, occupies flat smooth first bottoms along the Pajaro River. It is a recent alluvial soil from mixed sedimentary and acid igneous rock materials.

Owing to its favorable texture, Metz silt loam is easily tilled and is easily penetrated by water. Its moisture-holding capacity is better than that of other Metz soils. Drainage is excellent, but the soil is subject to overflow from the Pajaro River. The flat smooth surface makes it well adapted to general cultural practices, and it is not eroded.

This soil occurs only adjacent to the Pajaro River. All the land is under cultivation. The main crops are apples, lettuce, and sugar beets, and they return high yields.

Metz silt loam would benefit by applications of organic matter, but, owing to its calcareousness, it does not need applications of lime. This is an excellent soil and gives high yields. It is well adapted to general agricultural use, but where subject to overflow it is best used for summer crops, such as lettuce and sugar beets.

Metz silt loam, shallow phase (over Salinas soil material).—The surface soil of this phase of Metz silt loam consists of light grayish-brown to rather dull grayish-brown calcareous mellow silt loam typical of the Metz soil material overlying Salinas soil material. The change to the darker, duller brown of the Salinas soil is abrupt and occurs at a depth of 15 to 40 inches. The subsoil is noncalcareous to a depth of 48 to 56 inches, where it changes to the calcareous lower subsoil layer typical of the Salinas soils. The surface is smooth and gently sloping. The soil still is subject to occasional overwash.

The texture of this soil is such that it is easily cultivated and prepared for general truck farming. Its water-holding capacity is

high, and moisture penetrates readily. Drainage is good, and no erosion occurs.

Soil of this phase occurs only in the western end of the Pajaro Valley.

All the land is under cultivation. At present most of it is being used for lettuce, although some other truck crops are produced. Yields on this soil are high, and on the whole it is an excellent soil for general agricultural use.

SOQUEL SERIES

The Soquel soils, recently deposited alluvial soils, are derived from sedimentary rock, such as sandstone or shale. The parent materials have been transported from areas of relatively high rainfall. All these soils occupy gently sloping confluent alluvial fans. Drainage is generally good. The soils are subject to very little erosion but rather to a slow building up of the soil material as a result of outwash from higher slopes. They support a cover of redwood, tanbark oak, and some shrubs. Because of their high agricultural quality, practically their entire area is tilled. They constitute one of the best soils for fruit, berries, and vegetables in the area.

The surface soils, to a depth of 12 to 16 inches, are dark brownish gray to dark grayish brown. The subsoils and substrata consist of stratified deposits that are variable in texture and generally are somewhat lighter in color than the surface soils. No characteristic structure is evident, except possibly a cloddy structure in the heavier textured soils. These soils show no consistent zone of accumulation of clay, compaction, or other evidence of the development of a profile. The entire soil mass is slightly to moderately acid in reaction, in most places having a pH value of 5.8 to 6.3.

Soquel sandy loam.—The surface soil of Soquel sandy loam is dark grayish-brown friable slightly granular sandy loam to a depth of 10 to 18 inches. This grades into dull-brown loose sand that shows no compaction and in places contains some stones. This soil is very easy to till, and its friable character is favorable for plant growth. It is slightly acid (pH value 6.0 to 6.3). The water-absorbing and water-holding capacities are moderate. It contains a moderate quantity of organic matter, and, although it is not low in plant nutrients, the addition of fertilizer is well repaid in crop returns. It occupies flat areas in the larger stream valleys. Subsurface drainage is excellent.

The larger areas of Soquel sandy loam are in the Corralitos Creek bottoms, and a body is in Larkin Valley. Originally the vegetation was redwood and tanbark oak, but now the entire area is in orchards, mostly apple orchards, but small plots near the stream banks are devoted to cherries, strawberries, and bush berries. The trees are large and sturdy and return good yields, and the berries also give good returns. This is rated one of the best soils of the bottom lands in the area.

Soquel loam.—The 8- to 16-inch surface soil of Soquel loam is medium-textured loam or heavy-textured loam. When the soil is dry, the color is dark grayish brown or dark brownish gray, but it is darker when the soil is wet. Water and plant roots penetrate

readily. Tillage presents no difficulty except that if the soil is plowed when wet it becomes cloddy on drying. The surface soil is very slightly acid to neutral, ranging in pH value from 6.0 to 7.5. The subsoil is dark brown or grayish brown, and, with some variations as a result of stratification, it generally has a texture similar to or lighter than that of the surface soil. The material in this layer contains many worm holes and is slightly acid or neutral in reaction. The organic-matter content is medium to high, and no serious lack of plant nutrients is evident. The permeability and friability of this soil makes it retentive of moisture. Roots penetrate it readily, and it is an excellent agricultural soil.

Soquel loam occurs mainly along streams, where it occupies wide flat to gently sloping second and first bottoms. Surface water is largely absorbed, and erosion is not a problem.

A fairly large area of Soquel loam is mapped, chiefly in the creek bottoms north of Santa Cruz, Soquel, and Aptos; in Scott Valley; and in the northeastern part of the Pajaro Valley. A comparatively large body is in the valley south of Corralitos, and other bodies are in the Pajaro Valley east of Watsonville.

The native vegetation was redwood and tanbark oak, but now a large proportion of the land is under cultivation. Apples are the chief orchard crop, and the yield in many years runs as high as 1,000 or 1,200 boxes of fruit to the acre. This is a very valuable soil for lettuce, which yields an average of 150 crates an acre for each crop. Many of the orchards are being removed and replaced with lettuce, which gives a greater net return. In rotation with lettuce, some legume crop, such as horsebeans, should be grown and plowed under to aid in maintaining the soil fertility. In the smaller local stream valley areas miscellaneous crops, as corn, beets, and hay, are grown.

Table 6 gives the results of mechanical analyses of samples of two layers of Soquel loam.

TABLE 6.—*Mechanical analyses of two samples of Soquel loam in the Santa Cruz area, Calif.*

Sample No.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
	Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
578805	0-16	0.8	2.3	4.1	10.6	12.0	46.1	24.1
578806	16-72	1.2	3.1	4.7	10.9	12.3	42.2	25.6

Soquel loam, stony phase.—Soquel loam, stony phase, differs from typical Soquel loam in having a high content of stones throughout the soil mass. In an area mapped near Felton the stone content is about 75 percent quartz diorite boulders, and in two other areas the stones are chiefly sharp angular fragments of shale with a maximum diameter of 6 inches. The area near Felton occupies a flat terrace-like position, and the two other areas are on alluvial fans with considerable slope. One of these is near the mouth of Scott Creek and the other is one-fourth mile northwest of Chittenden. The last-named area is used for grain, and the first-named area is used for artichokes and brussels sprouts.

The soil has a pH value ranging from 5.2 to 7.3. The large content

of stones makes tillage difficult, and crops are likely to suffer from drought. This inextensive soil has little agricultural importance.

Soquel silty clay loam.—This soil has a dark grayish-brown heavy-textured silty clay loam surface soil and a stratified subsoil of similar or lighter texture. It is a low-lying valley soil, but in places it occurs on alluvial fans. The heavy-textured surface soil makes tillage difficult in preparing a good seedbed. Subsoil drainage is good. The entire soil is neutral in reaction. This soil is well supplied with plant nutrients and organic matter, is permeable to roots and moisture, and is not eroded.

One of the larger areas is 2 miles southeast of Watsonville; areas border Waddell, Scott, and Whitehouse Creeks, and several are near Corralitos.

The area along Scott Creek contains a high proportion of mica, which comes from quartz diorite rocks along Scott and Big Creeks and tends to make the material somewhat more friable than the typical soil.

A small area, 4 miles northeast of Felton, is included with Soquel silty clay loam in mapping. It differs from the typical soil in that it has a darker color and a larger content of organic matter. Unlike typical Soquel silty clay loam, the underlying material shows no stratification. The pH value is slightly higher—above 7.0.

The native vegetation on Soquel silty clay loam is redwood, tanbark oak, and associated growths. About 90 percent of the land is cleared and used for agriculture. The principal crops are apples and lettuce, which give excellent returns.

Table 7 gives the results of mechanical analyses of two samples of Soquel silty clay loam.

TABLE 7.—*Mechanical analyses of two samples of Soquel silty clay loam in the Santa Cruz area, Calif.*

Sample No.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
	Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
5788101	0-28	0 1	0.6	1 0	8 4	7 7	46 2	36.0
5788102	28-40	.1	1 2	2 3	36 1	17 8	21 2	21 3

LAGUNA SERIES

The Laguna series includes recent water-transported materials derived from coarse-textured sandstone. They have their source as outwash from the Moro Cojo, Arnold, or coarse-textured Hugo soils of the uplands. These recent alluvial soils have an undeveloped profile, although the soil material had been previously leached under comparatively high rainfall before it was deposited in its present position. These soils occupy fairly smooth slopes that have been incised to some extent by shallow channels carrying runoff from higher land. The runoff water frequently deposits material from the higher slopes. Runoff is rapid on the steeper fans, causing some movement of soil material, and drainage is excellent. The native vegetation consists of small ponderosa pine and brush.

The surface soils, to a depth of 10 to 14 inches, are light gray to light brownish gray, and they lack structural development. They

contain very little organic matter, except in the immediate 1- or 2-inch surface layer.

The soil material shows very little difference to a depth of 6 feet, as the profile is modified only by stratification. The pH value is about 5.0 in the surface layers and 4.5 in the subsoil and substrata. All the soils of this series have coarse sandy texture, high acidity, and low fertility. The soils of the Laguna series are related to the Corralitos soils but differ chiefly in that they are much lighter colored.

Laguna fine sand.—The 10- to 14-inch surface soil of Laguna fine sand is light-gray or light brownish-gray very loose fine sand. It contains very little organic matter. The subsoil shows little change in character, but it is slightly yellowish gray or lighter gray. The entire soil mass is strongly acid, having a pH value of 5.0 to 4.5.

This soil occurs on steeply sloping alluvial fans. Surface and subsurface drainage are excessive, and the water-holding capacity is low. These features combine to make the soil droughty. The soil is subject to periodical accumulation of soil material by deposition from the higher sandy eroding slopes at times of freshets. Its very low organic-matter content, together with its high acidity and its tendency to droughtiness, causes it to be a poor agricultural soil.

The largest area is east of Felton. A smaller body, the southwestern corner of which is darker than typical, is east of Bonnie Doon. The land supports a native vegetation of small ponderosa pine and brush. Only a small proportion of this soil is used for agriculture. Grapes and prunes are the only crops grown, and the yields are low. Grapes yield from one-fourth to three-fourths ton an acre, and prunes give very poor returns.

Two small areas of this soil along Soquel Creek contain a large proportion of stones. One is one-half mile south and the other is 2 miles south of Mountain School. They occupy low areas along the stream bed, indicated on the soil map by stone symbols, are only slightly better than riverwash, and have no present and little potential agricultural value.

ALVISO SERIES

The surface soils of members of the Alviso series range in color from brownish gray to dark gray and are calcareous, moderately high in organic matter, and mottled with iron stains. The material breaks into large angular clods when dry. At a depth of 7 to 10 inches the surface soils change to dark-brown or dark-gray subsoils, which pass into bluish-gray waterlogged silty clay and clay materials at a depth ranging from 2 to 6 feet. The upper part of the subsoils breaks into large semiangular clods, but with increased depth the material changes to heavy structureless clay. Mottling also increases with depth. The soil materials contain large quantities of saline salts and are stratified in many places. The water table stands from 2 to 6 feet below the surface.

These soils occupy flat areas adjacent to areas of tidal marsh, and they support saltgrass and associated saline vegetation. The Alviso soils are represented by Alviso clay, which occurs below the level of the Salinas soils in the Pajaro River Valley and slightly higher than tidal marsh.

Alviso clay.—The surface soil of Alviso clay ranges in thickness from 7 to 10 inches. It is brownish-gray to dark-gray silty clay

material that is high in organic matter, breaks up very cloddy, and in most places is calcareous. It is slightly mottled with iron stains, which increase in the subsoil until the water table is reached at a depth of 2 to 4 feet. The upper part of the subsoil consists of dark-brown to dark-gray clay changing to blue-gray clay at the level of the water table. The material in this layer breaks into very large chunks, but at a lower depth the clods change to massive heavy clay. This soil occurs on the flat stream flood-plain and delta areas near salt marshes, and the soil materials are highly saline.

An area occurs at the western end of the Pajaro River Valley, extending to the mouth of Harkins Slough. A small body is on the south side of the Pajaro River near its mouth.

This soil supports only a growth of saltgrass, pickleweed, and associated saline vegetation. Under natural conditions it has no value for agriculture except for pasture of low value, for which it is utilized at times. Its high salt content, low position, and undeveloped drainage limit its possibility of feasible reclamation.

PAJARO SERIES

The Pajaro soils are young alluvial soils derived mainly from mixed sedimentary rocks. The parent materials have been transported from regions having comparatively high rainfall. At one stage of development the Pajaro soils evidently were subjected to poor drainage, as indicated by mottling in the subsoils, but now these soils occupy smooth alluvial plains or basins having adequate run-off and good drainage. Practically all of the Pajaro soils are under cultivation. Before being cleared they supported a native vegetation of redwood, tanbark oak, and mixed grasses. They are used especially for the production of apples and lettuce (pl. 3, *A* and *B*).

The Pajaro soils have grayish-brown or dull-brown surface soils. At a depth of 12 or 14 inches these grade into somewhat darker slightly to moderately compact heavy-textured subsoils. Below a depth of 30 to 36 inches the material changes to lighter colored, permeable, and, in many places, lighter textured material. In some places the mottling is absent in the upper part of the subsoils but appears as yellow or brown stains in the lighter colored substratum. The material in all layers breaks into clods. This soil is moderately to strongly acid in reaction, having a pH value of 4.5 to 5.5 according to field test.

Pajaro sandy loam.—Pajaro sandy loam has a dull dark grayish-brown friable sandy loam surface soil extending to a depth of 12 or 15 inches, where it grades into a lighter grayish-brown slightly mottled upper subsoil layer that is slightly compact and faintly vesicular and breaks into soft clods. At a depth of 28 or 30 inches the material changes to light yellowish-brown vesicular very fine sandy loam mottled with yellow and brown. It has about the same degree of compaction as the upper subsoil layer and breaks readily into soft angular clods. This is underlain, at a depth ranging from 42 to 72 inches, by brown friable variably textured sediments. The soil is mildly to strongly acid throughout.

Pajaro sandy loam is a young soil formed in alluvial basins and plains. It was developed on outwash material from mixed sedimentary rocks, this material having been removed from regions of higher

A, Apple orchard on the Pajaro soils; *B*, Pajaro soils prepared for planting lettuce

rainfall. The surface is smooth, flat, and uneroded, and drainage is adequate.

This soil is easily tilled and has a fairly high content of organic matter. Its favorable structure and organic-matter content tend to make it easily penetrated by water and give it a good water-holding capacity.

The largest bodies occur in the immediate vicinity of Watsonville and Freedom, a fairly large area is in the vicinity of Amesto School, and other areas are north and northwest of Pinto Lake.

Practically all of Pajaro sandy loam is under cultivation. The original vegetation was probably redwood, tanbark oak, and other oaks. This soil is used mostly for apple growing, and some areas are devoted to general truck farming. It is well adapted to general farming. Its favorable texture and permeability promote the penetration and development of roots. The productivity of this soil is high. Apples return 800 or more boxes an acre, and approximately 150 crates a crop of lettuce are obtained, with two crops a year.

Pajaro loam.—Pajaro loam has a surface layer of light-brown to brown friable loam from 6 to 12 inches thick. This grades into yellowish-brown mottled slightly compact loam. At a depth of 24 to 35 inches the soil material changes to drab highly mottled slightly to moderately compact clay loam. Between depths of about 48 and 60 or more inches the soil material is yellowish-brown mottled slightly to moderately compact loam.

Pajaro loam has a gently sloping to nearly flat smooth surface, and drainage is adequate. These features, together with its excellent surface texture, makes it an easy soil to till. It has a good moisture-holding capacity and is permeable to water and plant roots.

The greater part of Pajaro loam occurs near Watsonville and Calabasas School, and a fairly large body is near Casserly School. Three bodies occur in basinlike depressions in the northern part of the area, one in the Big Basin, one north of the town of Boulder Creek, and the third where Kings Creek joins the San Lorenzo River.

The native vegetation on Pajaro loam was probably redwood, tanbark oak, and herbaceous plants. Practically all of this soil is now under cultivation. Most of it is used for apple orchards, and some of the largest yields of apples in the Santa Cruz area are obtained on the bodies near Watsonville. Smaller bodies of this soil are used for general truck farming, for which the soil is well suited. In general this is an excellent soil, well adapted to orchard or general truck farming.

Pajaro clay loam.—The 13-inch surface soil of Pajaro clay loam consists of grayish-brown friable clay loam. The upper part of the subsoil is gray to grayish-brown friable slightly compact clay loam highly mottled with yellow and rust brown. At a depth of about 23 inches this grades into lighter grayish brown mottled sandy loam or loam with a somewhat cloddy structure. Below a depth of 35 to 37 inches, the material consists of light yellowish-brown mottled friable stratified variably textured sediments. In some places this soil includes areas with a darker colored and more highly organic subsoil. The soil is moderately to strongly acid throughout, fairly high in organic matter, retentive of moisture, and easily cultivated.

This soil occupies alluvial plains and basins and has developed on alluvial outwash from mixed sedimentary rocks. The surface of the soil is smooth, drainage is adequate, and no erosion is evident.

As mapped, this soil includes a few small areas of slightly heavier textured surface soil. One body is 1½ miles northwest of Freedom near Calabasas School, and a smaller area is about 3 miles northwest of Freedom. Typical bodies of Pajaro clay loam are near Amesto School, just north of Freedom, and north of Green Valley School.

The native vegetation on this soil was redwood, tanbark oak, and other oaks. All the land is now under cultivation. Practically all of it is used for apple growing and only a small part for general truck crops. This is an excellent soil, well suited for either orchards or general truck farming.

As occurring in the Santa Cruz area, it includes an area of somewhat heavier texture than is typical, occupying the southern end of a former lake basin east of Amesto School. The surface is flat and may be covered with water during wet winter periods. In the late spring the water is removed by a system of drains and pumps, and summer crops are grown. Owing to the rather poor drainage and heavy texture, this soil is not quite so good agriculturally as typical Pajaro clay loam.

BOTELLA SERIES

The surface soils of the members of the Botella series, as occurring in this area, are very dark dull grayish brown, dark dull brownish gray, or nearly black. When dry, these layers have an irregular blocky to granular structure. They are acid, having a pH value of about 6.0. The organic-matter content is fairly high as compared with the other soils of this area. The upper subsoil layers, beginning at a depth of 12 to 18 inches, are similar in color, slightly compact, and typically heavier in texture than the surface soils. The material in this horizon generally breaks into clods, which crumble to granules under pressure. In general the subsoils are acid, with a pH value of about 6.0; but in this area the reaction is somewhat variable. The Botella soils on the floor of the Pajaro Valley are not so acid in reaction as those in the other valleys. The deeper material, beginning at a depth of 30 to 40 inches, is pale yellowish brown to grayish brown, rather friable, and lighter textured than the material above. It has no definite structure and is slightly mottled in some places.

The Botella soils are young alluvial soils developed on outwash material from areas of Hugo, Santa Lucia, and Cayucos soils. They occupy flat stream valleys and gently sloping narrow canyon bottoms. In the narrow canyonlike valleys north of Aptos, Soquel, and Santa Cruz the soil materials are stratified in places. Drainage is excellent. Soils of this series have a high agricultural value.

The Botella soils are associated with the Salinas and Soquel soils, all of which are formed in the same manner.

Botella clay loam.—The surface soil of Botella clay loam, to an average depth of 18 inches, is very dark dull brownish-gray heavy clay loam, which breaks up into clods or granules when plowed. The clods are rather firm but break down fairly easily under pressure. The subsoil, extending to a depth of 30 to 40 inches, is very dark brownish-gray moderately compact silty clay that breaks into firm rather hard clods. This layer overlies brown fairly friable loam

that is slightly mottled in some places. The soil material becomes more friable with depth.

Botella clay loam occupies flat bottom lands. It has developed from material washed from the surrounding hills and deposited by streams. A few bodies on Soquel Creek, Trout Creek, and Grover Gulch occupy narrow slightly sloping strips next to the stream channels. The soil material is moderately acid throughout, with a pH value of about 6.0.

The friable surface soil is easily tilled, and the nearly flat surface is favorable to irrigation. Moisture is readily absorbed and retained. Subsoil drainage is very slightly impeded by the heavy-textured subsoil but is not retarded enough to interfere materially with the production of crops. This soil is more or less subject to overflow and deposition of fresh soil material and is not eroded. The native vegetation probably consisted of grasses and a few shrubs and bushes.

Most of Botella clay loam is east of Watsonville along the Pajaro River as far as Chittenden. Small areas border Valencia and Corralitos Creeks.

The areas of this soil east of Watsonville are used almost entirely for the production of lettuce. The smooth surface, good water-holding capacity, and location of this soil are favorable for this crop, although it is not entirely free from the danger of frost. Some apples are grown, mainly Yellow Bellflower and Yellow Newtown, both of which yield well. In the smaller narrow areas along the streams this soil is used for miscellaneous truck crops and a few cherries, apples, and prunes. There are only small mixed orchards comprising 1 to 5 acres each in extent.

Botella clay loam is associated with the Salinas soils, which are calcareous in the subsoil; with the Soquel soils, which do not have such heavy subsoils; and with the Metz soils, which are brown calcareous soils. All are formed in the same manner and are more or less alike in profile characteristics.

Botella silty clay loam.—Botella silty clay loam has a very dark brown to dark dull grayish-brown granular silty clay loam surface soil, extending to an average depth of about 24 inches. The upper subsoil layer, to a depth ranging from 45 to 60 inches, is dark dull brownish-gray moderately compact silty clay. It breaks into clods that crumble under pressure to a granular condition. The deeper material consists of light-brown fairly friable silty clay loam. The reaction throughout is slightly acid. Owing to the high content of silt, the soil is very friable and granular, making tillage easy and affording excellent penetration of water. Botella silty clay loam is a young soil occupying flat bottom-land flood plains. It is developed on alluvial material derived from mixed sandstone and shale rocks, this material having been carried down from higher elevations and deposited by the various streams.

The structure, texture, and relief of Botella silty clay loam make it well suited to irrigated crops. This soil has a high water-holding capacity and provides favorable moisture conditions for plants. The subsoil, although slightly heavier in texture than the surface soil, is not heavy enough to impede subsoil drainage. Botella silty clay loam is a productive soil. Erosion is not evident, and the soil is more or less in

the process of being built up by deposition of fresh soil material.

With the exception of one or two small bodies, all this soil is east of Watsonville, northeast of Watsonville Junction, and at Vega. One small body borders Valencia Creek northeast of Aptos.

The native vegetation probably consisted of grasses and a few shrubs, but now all the land is under cultivation. It is used almost exclusively for the production of lettuce, although some apples and miscellaneous crops are grown. Yields of all crops are fairly high. Although this soil is fertile, heavy applications of manure are made on the land for lettuce, mainly to replenish the large supply of nitrogen that this crop demands.

Botella silty clay loam is associated with the soils of the Salinas series. In general, this soil is slightly browner than the other Botella soils.

Botella clay.—The surface soil of Botella clay, to an average depth of 12 inches, is very dark dull brownish-gray clay that breaks, when plowed, into hard clouds. When wet this soil becomes darker and is rather sticky and plastic. The subsoil, extending to a depth of 30 to 45 inches, is dull brownish-gray slightly compact clay having a hard irregular blocky structure. Underneath this layer is light yellowish-brown friable silt loam, which becomes more friable with depth. The soil mass is slightly to moderately acid throughout.

Because of its clay texture, this soil is not easily tilled, except under certain favorable moisture conditions. When too wet it is sticky and plastic, and when dry it becomes very hard and the clods are not easily broken. The water-holding capacity is high, but the soil gives up only moderate quantities of moisture to plants.

This soil is high in organic matter and in plant nutrients. No destructive erosion has taken place, and the soil is in a slow process of being built up by deposition of alluvial material. Both surface and internal drainage are rather slow, owing to the heavy texture.

The native vegetation probably consisted of grasses, shrubs, and a few trees along the waterways, but now all this land is under cultivation. It is used mainly for the production of lettuce, with only a very small area in other crops. This soil is not very well adapted to trees or orchard crops because of its heavy texture.

All of Botella clay, with the exception of one or two small bodies, occurs at a short distance northeast of Watsonville, at Watsonville Junction, and 2 miles east of Vega. One small area is on Bates Creek north of Soquel. Approximately 2 square miles is the total extent of Botella clay in the area covered by this survey. It is associated with the soils of the Salinas series, to which it is similar in mode of formation and profile development and from which it is distinguished by its lower lime content.

SALINAS SERIES

The Salinas soils are young soils developed on smooth alluvial valley deposits derived from material of mixed mineralogical composition. The soil materials have been washed from areas of lower rainfall than that existing in the Santa Cruz area and have been modified to some extent by soil-development processes since deposition. Runoff is adequate, and drainage conditions are normally good. Practically all of the Salinas soils are under cultivation. The

original vegetation consisted primarily of grasses and herbaceous plants.

Soils of the Salinas series are characterized by having dull-brown, dark grayish-brown, or brownish-gray noncalcareous surface soils, from 12 to 16 inches thick. They have a cloddy structure. They grade into dark brownish-gray slightly compact calcareous slightly heavier textured subsoils. Lime occurs as small seams and soft concretions at a depth ranging from about 30 to 40 inches. This layer grades into light-brown or light rust-brown calcareous material of variable texture, which is friable and permeable to water and deep development of roots. The Salinas soils are similar in many respects to the Botella soils, differing mainly in their calcareous subsoils and also in being formed of material of more mixed mineralogical composition.

Salinas silty clay loam.—The surface soil of Salinas silty clay loam consists of dark grayish-brown silty clay loam, 12 to 14 inches thick. This grades into a subsoil of dark grayish-brown slightly compact faintly calcareous silty clay, which extends to a depth of 30 to 40 inches, where it grades into the lower subsoil layer. The lower subsoil layer, extending to a depth of 50 to 72 inches, is rust-brown loose calcareous material of variable texture.

Salinas silty clay loam is formed on outwash material from sedimentary and crystalline rocks. It occupies smooth to gently sloping alluvial terraces near the Pajaro River. Its favorable surface and position make it adaptable to intensive cultivation and irrigation and also reduce erosion to a minimum. This soil is permeable to moisture and, owing to its rather heavy texture, has a high water-holding capacity. It is fairly easy to cultivate, is productive, and is an excellent soil for general agricultural use.

Although not extensive, this soil covers a larger area than the other member of the Salinas series. Several bodies are in the extreme western part of the Pajaro Valley near the Pajaro River, and several are on the western edge of Watsonville and in the eastern part of the area near Aromas. The largest body is near Watsonville Junction.

All the land is irrigated and used for the production of lettuce, peas, and sugar beets. Lettuce is the crop most widely grown, and favorable yields are obtained. Excellent crops of sugar beets are also produced.

Salinas silty clay.—Salinas silty clay, to a depth of about 12 to 18 inches, consists of dark dull grayish-brown mildly calcareous or very slightly calcareous friable silty clay. The subsoil, to a depth of 20 to 30 inches, consists of grayish-brown calcareous slightly compact cloddy silty clay underlain by grayish-brown friable slightly calcareous silty clay. Below this, dull brownish-gray calcareous friable silty clay reaches to a depth of more than 65 inches. The parent alluvial materials of Salinas silty clay are derived from a wide range of sedimentary and crystalline rocks. The relief of this soil is that of a gently sloping or almost flat smooth alluvial terrace.

When plowed, this soil turns up in large clods, but these clods crush easily when worked under proper moisture conditions. The soil absorbs and retains water well. Surface drainage in most places is good, but subdrainage is only fair to good. In the lower end of

the Pajaro Valley bordering the muck and peat deposits of the Watsonville Slough, Salinas silty clay has imperfect drainage, as evidenced by the mottling in the subsoil.

Salinas silty clay occurs in the Pajaro Valley. The largest area is the one along Watsonville Slough mentioned above. Two bodies are in the eastern part of the valley, one near Aromas and the other near Vega.

All this soil is under cultivation and irrigation. The original native vegetation was herbaceous. Lettuce is the principal crop grown, and favorable yields are obtained. A few areas are planted to sugar beets or used for general truck farming. Salinas silty clay is a good soil for lettuce and an excellent soil for sugar beets. Its heavy texture tends to give it a very high water-holding capacity. On the whole, it is a good soil and fairly well suited to general truck farming.

MARINA SERIES

The Marina soils are developed on transported wind-laid or wind-modified sandy coastal terrace or dune materials of mixed geological origin. These soils have young profiles, and there is very little accumulation of clay in the subsoils or other evidence of development of a profile. They have rolling to undulating relief, and the sandy soils are fairly well stabilized by growing vegetation. The native cover consisits of oak, chaparral, and grasses. Subdrainage in most places is excessive and surface runoff is slight. In cleared fields on the rougher areas wind erosion is often severe, with a resulting deposition of sandy material and burial of crops. These soils generally are associated with and are somewhat similar to dune sand and soils of the Elkhorn series.

The surface soils of members of the Marina series, to a depth of 12 to 18 inches, are brown or rich brown and normally become slightly redder or a richer red when wet. These soils have a single-grain structure and a sandy texture. Grass roots are noticeable in the soil, but the organic-matter content is generally low. The subsoils are yellowish brown or light brown in most places, being somewhat lighter colored than the surface soils. The texture of the subsoils is about the same as that of the surface soils, but sufficient colloidal clay has accumulated to make the subsoils slightly compact. In places, thin seams ranging from 1 to 3 inches in thickness consist of somewhat red sandy compact material that is very softly cemented by sesquioxides. The deeper substratum consists of reddish-brown or yellowish-brown sand that normally has little or no compaction and breaks to a single-grain structure. The surface soils of the members of the Marina series are distinctly acid in reaction, most of them having a pH value between 5.0 and 6.0; and the lower layers are somewhat more acid than the surface soils, having a pH value between 4.5 and 5.8. The water-holding capacity and, in general, the fertility are low.

Marina sand.—The 16- to 20-inch surface soil of Marina sand consists of brown loose sand containing little organic matter. It is underlain by a somewhat lighter brown very slightly compact structureless sand subsoil to a depth of 36 to 40 inches, where the material rests on reddish-brown to light yellowish-brown loose sand, which continues unchanged to an undetermined depth. The character, po-

sition, and relief of Marina sand indicate that this soil is developed on old dune sand and strongly wind modified sandy coastal-plain materials.

The open, loose character of the sand makes tillage very easy, but the water-holding capacity is very poor, and underdrainage is excessive. The advisability of pumping water for irrigation is doubtful, because of this excessive underdrainage and the difficulty of obtaining water. Because this soil is located near the ocean, the heavy fogs doubtless supply some moisture for plants, but the quantity is small and cannot be relied on.

Although the relief is undulating to rolling, erosion caused by runoff is very slight, as the absorption rate of the sandy material is high. The surface soil is subject to some wind erosion, but a cover of vegetation effectively prevents this.

The largest area of Marina sand is north of the Pajaro River Valley between Harkins Slough and the ocean. Very much smaller areas occur along the coast as far north as Aptos, and two bodies are along the coast 4 and 6 miles, respectively, west of Santa Cruz.

The native vegetation is grass and brush, but brush covers a comparatively small proportion of the total area mapped. The cultivated areas are used chiefly for grain and beans, but yields are low, owing to low fertility of the soil and insufficient water. Because this soil is loose and porous, it remains warm in the winter, allowing the cultivation of some special crops, such as potatoes and peas, which are planted in November and December. Heavy applications of nitrogen-carrying fertilizers are necessary for successful crops.

ELKHORN SERIES

The Elkhorn soils are developed on old sandy coastal-plain deposits derived from material of mixed geological origin. These soils occupy elevated sandy marine terraces near the ocean, toward which they gently slope. They occur under an annual rainfall between about 15 and 25 inches.

Surface drainage in most places is adequate. In some places, particularly on the lower terrace slopes, some sheet erosion is caused by fairly rapid runoff, especially where there is no vegetative cover during the rainy season. Subdrainage is somewhat restricted by the moderately compact subsoil. These soils normally support a cover of grass, fern, and brush—mostly fern.

The surface soils of members of the Elkhorn series, to a depth ranging from 8 to 20 inches, are brown, grayish brown, and in places reddish brown. The reddish-brown color is intensified when the soil is wet. The sandy loam has a single-grain structure, whereas the heavier textured members have a granular or irregular blocky structure. The surface soils are moderately acid in reaction, having a pH value of 4.6 to 5.1. Grass roots are present in the surface soils, but the organic-matter content is low. The subsoils are reddish brown and fairly dense and compact, particularly when dry. The colloidal clay content is fairly high, although the material may not appear to be very heavy in texture, owing to the high content of sand. The material in the subsoil layers breaks into fairly hard clods having sharp angular corners. The subsoils show considerable mottling of red and yellow and contain many iron concretions about the size of a pea.

Moisture or plant roots do not penetrate them easily. The reaction is distinctly acid. The pH value ranges from 5.0 to 6.5.

The underlying substratum is very variable in texture and density, ranging from fairly friable loamy sand or sand that has a single-grain structure to compact sandy clay loam that is fairly dense. The color also is variable, and the reaction is distinctly acid. Considerable sand but normally no gravel is present in the parent material. The Elkhorn soils adjoin the Pinto and Moro Cojo soils in the higher areas and the Marina soils in the areas near the ocean. In profile they resemble the Pinto soils in many respects.

Elkhorn sandy loam.—Where typically developed, the surface soil of Elkhorn sandy loam consists of brown sandy loam from 8 to 20 inches thick. It contains little organic matter and has a moderately acid reaction. The subsoil is reddish-brown moderately compact sandy loam or sandy clay loam that has an acid reaction (pH value 4.8 to 5.7). This is underlain by yellowish-brown to reddish-brown variably textured material. This also has an acid reaction (pH value 5.0 to 5.7).

This soil has fairly rapid surface drainage, but the compact subsoil restricts its permeability to roots and water. Sheet erosion is rather severe on some of the sloping areas. The areas with the denser subsoil have more surface runoff during the rainy season and are eroded to a greater extent than those having a more permeable subsoil. An adequate amount of moisture cannot be stored in the soil, and this, to some extent, accounts for the somewhat droughty condition in the summer.

Elkhorn sandy loam occupies a fairly large area extending from a point south of the mouth of the Pajaro River eastward along the boundary of the survey. A large area lies north of the mouth of the river near San Andres School. The area south of the Pajaro River in Monterey County differs from the one north of the mouth of the river in that the subsoil is denser—in places sandy clay loam and in places sandy clay. The substratum is slightly to moderately compact sandy clay loam. This area also contains a considerable number of iron concretions in the subsurface layer.

Several small bodies of this soil about 1½ miles north of Port Watsonville have a loam surface soil, a higher organic-matter content, somewhat higher fertility, and higher water-holding capacity. Because of these characteristics, these particular bodies of soil are somewhat better for agricultural purposes than the areas of coarser textured soil.

Smaller isolated areas occur along the coast. Included with this soil as mapped are bodies having a loamy sand surface soil and a sandy loam or loam subsoil. These areas have a somewhat lighter textured and somewhat more permeable subsoil than is typical of Elkhorn sandy loam.

The native vegetation on Elkhorn sandy loam is chiefly wild radish, sorrel, foxtail, bronco grass, fern, and brush, and only a few native trees. More than 90 percent of the area of this soil has been cultivated. The most widely grown crops are beans, peas, grain, grain hay, and potatoes. These crops are usually grown without irrigation, and results are only fair. In general, Elkhorn sandy loam is not a very productive soil unless considerable effort and expense are used.

Strawberries, artichokes, brussels sprouts, and some flowers have given fairly good returns with irrigation and fertilizer. To some extent this soil is used for the production of winter peas and early potatoes, as its sandy character causes it to absorb more heat than nearby heavier textured soils. These crops are usually planted in November and December, and heavy applications of nitrogen-carrying fertilizers are necessary in order to produce good crops.

Elkhorn loam.—Elkhorn loam has an 8- to 20-inch brown surface soil that is friable when wet. It contains more organic matter and has a higher water-holding capacity than Elkhorn sandy loam. The subsoil is brown moderately compact gritty loam, mottled with yellow and red soft iron concretions. This changes gradually to light-yellow or reddish-brown friable sandy loam. The reaction of the surface soil is moderately acid and that of the subsoil strongly acid.

This soil occurs chiefly in the lower lying smooth bodies within areas of Elkhorn sandy loam and is subject to deposition of eroded material from the higher land that surrounds it. Owing to its finer texture, it is a somewhat better agricultural soil than Elkhorn sandy loam. Tillage is easy, but the moderately compact subsoil does not allow free penetration of roots or water.

The native vegetation on this soil is chiefly wild radish, sorrel, foxtail, bronco grass, fern, and brush. Nearly all of the land is under cultivation to beans, peas, grain, grain hay, and potatoes. Yields are only fair, but where the land is irrigated and fertilized, much better yields result. The grazing capacity of Elkhorn loam is fairly low.

Several small bodies of this soil occur about 1½ miles north of Port Watsonville. It is not an agriculturally important or extensive soil in this area.

BEN LOMOND SERIES

The Ben Lomond soils are developed on alluvial materials derived from sedimentary and granitic rocks. They have youthful profiles. Some accumulation of colloidal clay and sesquioxides in the subsoils, along with fairly high acidity, give evidence of soil development under a comparatively high rainfall. Soils of this series occupy smooth sloping terraces and alluvial fans. The native cover consists of redwood, coast live oak, tanbark oak, laurel, madrone, and other trees. Runoff is not excessive, owing to the dense cover, but surface drainage and subdrainage are good.

The 10- to 18-inch surface soils are light brown or brown and in general contain considerable mica. They are porous, friable, and granular. The reaction is medium to strongly acid (pH value 5.0 to 6.0). The subsoils are brown, somewhat gritty, and slightly heavier textured than the surface soils. They are slightly compact, contain some accumulated colloids, and break into cloddy aggregates that are harder than the granules of the surface soils. The reaction is medium acid, as the pH value is 5.0 to 6.0. Although they are somewhat more compact than the surface soils, they are readily permeable to moisture and plant roots. The underlying substrata are composed of variably stratified soil materials that generally contain gravel of mixed geological composition and have about the same acidity as the subsoils, that is, a pH value of 5.0 to 6.0.

Ben Lomond loam.—The surface soil of Ben Lomond loam, to a depth of 10 to 18 inches, consists of loose or friable loam containing

some rather sharp angular quartz fragments, some gravel with a maximum size of about three-fourths inch in diameter, and small to rather large quantities of mica. This is underlain, to a depth of 36 to 48 inches, by slightly heavier loam that is slightly compact yet permeable to roots and moisture. This rests on a looser layer of stratified sediments containing rounded gravel and stones and much sharp angular grit. This lower layer extends to a depth of 6 feet or more.

The coarse soil particles aid in maintaining a good physical condition, and when wet the soil is not very sticky. It is easily tilled, seldom bakes hard on drying, but contains only low to medium quantities of organic matter. It is not highly retentive of moisture. Both surface and subsoil drainage are good to excessive, and the soil is moderately productive, although medium to strongly acid. Under native cover it supports an excellent growth of redwood, Douglas-fir, tanbark oak, coast live oak, and madrone. Most of this soil is now covered with second-growth forest, and the heavy cover prevents erosion. The cleared areas are used mostly for grass hay and pasture.

This soil occupies rather sloping terraces and alluvial fans along the San Lorenzo River and Boulder Creek. It is somewhat subject to deposition of fresh soil material rather than to erosion, although it contains numerous gullies. The quantity of mica in the soil material varies from place to place. Near Boulder Creek and Brookdale, especially on the west side of the stream, the soil is highly micaceous, most of the material having washed down from the steep eastern slopes of Ben Lomond Mountain, which is occupied by Holland soils formed from granitic rocks. Near Felton and on the eastern side of Boulder Creek and the San Lorenzo River, the soil is developed on outwash, mainly from Hugo soils, which are formed from sedimentary rocks, although they contain some mica and granitic material.

The agricultural value of this soil differs considerably. The soil is not very extensive, and it occurs in a section where the land is used more for recreational than for agricultural purposes.

Ben Lomond loam, stony phase.—Areas of the stony phase of Ben Lomond loam occur on the west side of the San Lorenzo River and Boulder Creek next to the slopes where the soils are developed from granitic rocks. The quantity of stone varies, but in most places it is so excessive that the land would be difficult to till. The soil supports a good growth of trees (redwood, madrone, Douglas fir, tanbark oak, and coast live oak) and shrubs. It has somewhat steeper slopes than typical Ben Lomond loam and has a lower water-holding capacity.

In several small bodies along Soquel, Bear, and Zayante Creeks, the stone and gravel are derived entirely from sedimentary rocks. This soil is poor agriculturally and supports mainly a dense growth of brush. One or two small areas on Soquel Creek have been cleared and planted to pears, but the orchards have been abandoned.

PINTO SERIES

The Pinto soils are developed on old unconsolidated coastal-terrace deposits consisting primarily of wash from sandstones or shales, but they contain an admixture here and there of material from other rocks. They have strongly developed profiles, with considerable accumulation of colloidal clay in the subsoils. The Pinto soils are more

or less associated with the soils of the Elkhorn and Watsonville series, lying between them in geographic position and being intermediate between them in general character and degree of profile development.

Soils of this series occupy smooth terraces from 50 to 75 feet above the valley land. The native vegetation consisted of shrubs and grasses, but most of this has been cleared off and the land put under cultivation. Surface runoff is adequate in most places, owing to the gently sloping relief, but subsoil drainage is restricted considerably by the fairly dense subsoils. Some gullies have formed on the terrace slopes.

The surface soils of members of the Pinto series, extending to a depth of 12 to 16 inches are brown to light reddish brown. In the lighter textured types the surface soil is friable, but in the heavier textured types the surface soil is more compact and breaks up more cloddy. In some areas where the surface soil is extremely thick, the lower part of the surface layer is mottled with yellow and brown stains, generally is slightly heavier textured, and is somewhat more dense and compact than the immediate surface soil material. The subsoils are reddish brown to light brownish red, moderately compact, and considerably heavier in texture than the surface soils, and the material breaks into hard angular clods or blocks. The subsoils have a strong to medium acid reaction, the pH value ranging from 5.0 to 5.7. In most places the subsoils contain considerable brown and yellow mottling and soft round iron concretions. Although the subsoils of the Pinto soils are somewhat dense and compact, they are not so dense as those of the Watsonville soils, nor do they have such a high content of colloidal clay. The substratum consists of yellowish-brown moderately compact material that is rather massive but breaks down easily under pressure. This material generally is somewhat lighter textured than the subsoils and contains considerable gravel, which is well weathered and somewhat soft.

Pinto sandy loam.—The 12- to 18-inch surface soil of Pinto sandy loam is dark-brown friable sandy loam of rather loose structure. When wet this material is richer brown or more reddish brown. The subsoil, extending to a depth of 24 to 30 inches, is reddish-brown moderately compact sandy loam or sandy clay loam, which breaks into clods or blocks. The material in this layer is not very porous, and water does not penetrate it rapidly. Underlying this heavier textured subsoil is yellowish-brown moderately compact sand or sandy loam, which is low in organic matter and massive in structure, but fairly permeable to water. The surface soil and the upper subsoil layer are medium acid and the lower subsoil layer is slightly acid.

Pinto sandy loam occupies fairly high, smooth, gently sloping terraces. It has developed from mixed sandstone and shale alluvial outwash material from steep slopes. The sandy loam texture of the surface soil is favorable to tillage and to penetration of water. This layer contains much fine silt and clay material, giving it good water-holding capacity and causing it to crust or bake slightly on drying. The subsoil has good water-holding capacity, but, owing to its density and compactness, roots do not penetrate very far, and subsoil drainage is considerably restricted. Surface runoff has caused some erosion, mainly of the gully type. The native vegetation consisted

principally of grasses and shrubs, but most of this has been cleared and the soil put under cultivation.

Pinto sandy loam occurs along the coast between Santa Cruz and Watsonville. The larger areas are southeast of Aptos, about three-quarters of a mile west of Santa Cruz. Two small bodies occur as far north as Davenport.

Few crops are grown on this soil, as it is limited in adaptation because of its heavy-textured subsoil. Grain and grain hay are the chief crops. Yields of hay range from 1 to 4 tons an acre, depending largely on the rainfall during the winter. A few small apple orchards are on this soil, but yields are low in comparison with those obtained on the soils of the bottom land. Where not cultivated, this soil can be used for pasture to fair advantage. It is better adapted to shallow-rooted than to deep-rooted crops.

Pinto sandy loam is more or less associated with the soils of the Elkhorn and Watsonville series, being intermediate between them in profile character and development.

Pinto loam.—The surface soil of Pinto loam is rich-brown, brown, or dull-brown granular loam from 12 to 18 inches thick. It is strongly to medium acid (pH value 5.0 to 6.0) and low in organic matter. The subsoil, to a depth of 36 to 44 inches, is rust-brown to rich-brown sandy clay loam or sandy clay, mottled in many places with red, yellow, and brown stains and in some places contains small iron concretions or pellets. When dry it is hard with a blocky structure, and when wet it is fairly plastic and sticky. The subsoil is not so acid as the surface soil (pH value 6.0 to 7.0). Underlying this heavy mottled layer is yellowish-brown moderately compact sandy loam containing some gravel of mixed sandstone and granitic origin. This layer is mottled with red, yellow, and brown stains and is slightly acid.

Pinto loam occupies fairly high terraces having a gentle slope and smooth relief. This soil is rather easily tilled, but it tends to clod and crust at the surface when dry. The surface soil has good water-holding capacity, but the heavy-textured subsoil retards the penetration of water and roots. The surface soil dries out rapidly, and the soil is not adapted to deep-rooted crops and trees. Erosion is not so active on this soil as it is on Pinto sandy loam. The native vegetation probably consisted of grasses and shrubs, but through cultivation and pasturing this covering has been removed.

Most of this soil is between Watsonville and Corralitos in the vicinity of Pinto Lake. Small bodies occur on the terraces above Aptos and Soquel, and a large area is northwest of Santa Cruz.

Pinto loam is used mainly for grain hay and pasture and to some extent for apricots, apples, and miscellaneous truck crops. Grain hay does fairly well during favorable seasons, yielding from 1 to 4 tons an acre. Apricots and apples do not yield well. Although the trees thrive fairly well, the fruit is small and yields are low. Of the apples, the Yellow Newtown does the best and yields on the average about 300 boxes an acre. Strawberries do fairly well. Heavy applications of fertilizer are used on this soil, and substantial increases in crops result.

Pinto loam, compact-subsoil phase.—The compact-subsoil phase of Pinto loam differs from typical Pinto loam in having a more compact and redder subsoil, through which roots and water find it al-

most impossible to penetrate. The surface soil is dull-brown loam extending to a depth of 12 to 18 inches. It is cloddy or granular, has good water-holding capacity, and is fairly easily tilled. Surface penetration of water is good, but subsoil drainage is poor.

This soil occupies slightly more sloping and higher terraces than typical Pinto loam. It occurs along the base of the foothills between Aromas and Corralitos.

Apples, apricots, berries, and grain have been planted, but with poor results. Yields of apricots and apples are low, and the trees are not long lived. The soil is acid and low in fertility, making it necessary to apply barnyard manure and commercial fertilizers in order to produce fair crops. Soil of this phase is more closely associated with the Watsonville soils, differing mainly in color.

Pinto clay loam.—The surface soil of Pinto clay loam is brown to light reddish-brown clay loam, which breaks into angular clods when plowed. When dry the clods are hard and difficult to break. The surface soil is strongly acid, having a pH value of about 5.0. The upper subsoil layer, beginning at a depth of 12 to 18 inches and extending to a depth of 20 to 24 inches, is reddish-brown slightly compact clay loam, which breaks into clods. It is only slightly less acid than the material in the surface soil. The lower subsoil layer is light reddish-brown to light brownish-red moderately compact clay loam with a hard angular cloddy to blocky structure. Underlying this is yellowish-brown moderately compact gravelly loam or gravelly clay loam.

The entire soil mass is acid, ranging from strongly acid in the surface soil to moderately acid in the lower subsoil layer. It is rather low in organic matter and soil fertility, and fairly heavy applications of fertilizer are necessary in order to produce fair crops. This soil is developed on gently sloping terraces consisting of old alluvial material, developed mainly from sandstone and shale sources but with a slight mixture of granitic material. The heavy-textured surface soil makes tillage rather difficult, as the soil dries out very hard. The surface soil has good water-holding capacity, but the heavy subsoil tends to retard percolation, and the soil dries out quickly in dry weather. Although the smooth surface is favorable to irrigation, subsoil drainage is so poor that only a few irrigated crops can be grown. Very little erosion has taken place. The native vegetation consisted of coast live oak and brush, but cultivating and pasturing the land have destroyed the original cover in most places.

Bodies of this soil are southeast and east of Corralitos. Only a very small total area is mapped.

About one-half of the land is in crops; the rest is used for pasture or is not used. Grain hay is the chief crop, fair yields being obtained under favorable conditions. Some apricots are grown, but these do not do well. Truck crops and strawberries yield fairly well when the land is given heavy applications of manure and commercial fertilizers. This soil is not adapted to the production of tree fruits, because the heavy subsoil restricts drainage and the penetration of roots.

LOCKWOOD SERIES

The surface soils of the Lockwood series are dull brownish gray or dull grayish brown, becoming considerably darker when wet. They are medium textured, consist of granular friable material that

breaks up easily with tillage, are easily penetrated by roots and water, and contain many worm casts and root holes. These layers are medium acid, contain a moderate quantity of organic matter, and range in thickness from 10 to 15 inches.

The upper subsoil layers, to a depth of 25 to 35 inches, are slightly lighter colored than the surface soils, being dull gray to grayish brown and somewhat mottled with iron stains, but the texture of the two layers is about the same. The material in the upper subsoil layers is slightly compact, breaking into angular blocks rather than rounded clods, is fairly permeable to roots and moisture, and contains numerous root holes and worm casts, especially in the upper part of the layers. The reaction is medium to strongly acid.

The lower subsoil layers, extending to a depth of 45 to 55 inches, consist of dark brownish-gray or grayish-brown medium acid compact heavy-textured material containing considerable quantities of partly weathered siliceous shale fragments. The aggregates break under pressure with some difficulty into sharply angular fragments. This layer is not very permeable to roots and water, and percolation of water often is retarded, causing mottlings in the layer above.

The substratum, extending to a depth of 6 or more feet, consists of stratified layers of soil material and angular shale fragments. The soil material is brown or grayish brown, granular and friable, noncompact, medium acid, and easily penetrated by roots and water, but it contains few roots because of the less pervious layer above.

The Lockwood soils are developed on alluvial outwash from the Santa Lucia soils and Monterey shales. They occupy smooth gently sloping terraces at the base of hills along the coast from Santa Cruz northward. Gully erosion is not very severe, and these soils in many places are subjected to deposition of fresh soil material. Because of the smooth gently sloping relief, runoff is not excessive. Surface drainage is good, but subdrainage is somewhat restricted. Under virgin conditions these soils generally are covered with a dense growth of brush—mostly sagebrush and kidneywort, or coyote brush.

Although they have less pronounced development of a profile than the soils of the Watsonville series, the Lockwood soils are associated with the Watsonville along the coastal plain north of Santa Cruz. Where they occur on the same terraces, the Lockwood soils occupy the higher part closer to the hills. Except in the stony areas, they are superior agriculturally to those of the Watsonville series.

Within a radius of 2 or 3 miles from Davenport the surface soils of members of the Lockwood series are neutral to somewhat calcareous, owing to deposition of calcareous dust from the cement plant.

Lockwood loam.—Lockwood loam, to a depth of 10 to 15 inches, is dark dull grayish-brown or brownish-gray loam, which is easily tilled, breaking up under tillage to a friable condition. It is underlain, to a depth of 25 to 35 inches, by slightly lighter colored loam that is slightly compact and contains some iron stains, which indicate imperfect drainage. The obstructed drainage, which results in a temporary perched water table, is caused by a compact less permeable underlying layer of dark brownish-gray or grayish-brown gravelly clay loam, which extends to a depth of 45 to 55 inches. Below this compact layer the soil and angular shale gravel are stratified, in many places to a depth of 15 or more feet.

This soil occurs on smooth gently sloping terraces adjacent to the Watsonville soils along the coast from Santa Cruz northward to Scott Creek. The soil parent material is outwash from the nearby hills occupied by soils of the Santa Lucia series and siliceous shales. The terraces lie from 50 to 200 feet above sea level and are cut by numerous steep-sided ravines.

Under natural conditions this soil was covered by a dense growth of low brushy shrubs. Cleared areas are subject to mild erosion, but because of the type of farming, erosion is not very severe. Under dry-farming conditions this soil is used for grain hay or pasture and is seldom left bare during the rainy season. Under irrigation, it is used principally for artichokes and brussels sprouts. These crops are clean cultivated but are furrowed on the contour, having numerous dams along the rows, that almost wholly prevent runoff. Surface drainage is good, but subsoil drainage is restricted. The soil is easily tilled, has a fair content of organic matter, and is fairly retentive of moisture.

Artichokes yield from 90 to 150 boxes an acre, somewhat more than the yields obtained on the soils of the Watsonville series. For this crop the land is irrigated rather lightly but frequently, usually every 2 weeks, during the summer, necessitating careful use of water and careful weeding and management of the crop to insure maximum yields. Most of the fields devoted to artichokes and brussels sprouts are enriched with manure and often with commercial fertilizers. Brussels sprouts yield from 3,500 to 6,000 pounds an acre on this soil. This crop is usually grown on the sandier soils and the artichokes on the heavier textured soils; consequently the acreage of brussels sprouts on Lockwood loam is not nearly so large as that on Watsonville sandy loam in this locality.

In this area a number of small bodies are included in which many sharp, angular fragments of stone and gravel occur on the surface, and the underlying material is much more stony and gravelly than in the typical soil. The stones on the surface greatly hinder tillage operations and also reduce the amount of water the soil can hold, making it much less productive than typical Lockwood loam. These areas are shown on the map by stone symbols.

WATSONVILLE SERIES

The Watsonville soils are developed on old unconsolidated coastal-terrace materials derived from sandstone and shale material under an annual rainfall ranging from 20 to 30 inches. They occupy gently sloping terraces at an elevation ranging from about 20 to 50 feet above sea level. In places they have a hog-wallow microrelief characterized by small mounds and depressions. Runoff is adequate, but subsurface drainage is very slow, owing to the presence of dense clay subsoils. The native cover consists of grasses and shrubs.

The surface soils, to a depth of 10 to 20 inches, are dull grayish brown, are rather friable, and have a granular structure. The pH value ranges from 5.0 to 5.5. The content of organic matter is medium. In most places the lower part of the surface soils is somewhat more compact than the upper part. The surface layers are underlain by light-gray vesicular layers of sandy loam ranging from 2 to 8 inches in thickness and containing brown iron concretions about the size of a pea. This

material is abruptly underlain by dark brownish-gray very compact sandy clay. The topmost 3 to 5 inches of this layer has a columnar structure, and many of the columns have rounded biscuit-shaped tops.

The lower part of this dense clay layer is generally somewhat lighter colored and in many places is mottled with yellow and brown stains. The material breaks into angular blocks that, on drying, are hard and dense. The substrata consist of yellowish-brown compact heavy-textured sediments mottled with yellowish-brown iron stains. These become somewhat lighter textured with depth. All the soil materials have a pH value of 5.0 or less.

The Watsonville soils were not recognized in the earlier reconnaissance soil survey and were included with the dark-colored soils of the Montezuma and other series.

Watsonville sandy loam.—The surface soil of Watsonville sandy loam is dark dull grayish-brown friable sandy loam with a single-grain to granular structure. This layer is rather thick, extending to a depth ranging from 16 to 30 inches. In some places the lower part is very slightly heavier textured and darker, but it is slightly less acid than the upper part, which is strongly acid (pH value 5.0). Below this slightly heavier layer is light-gray to gray vesicular porous sandy loam that is strongly acid in reaction. This rests abruptly on a heavy plastic sandy clay subsoil, the upper 3 or 4 inches of which has the form of well-developed columns, which gradually change to blocks and angular clods. The depth to the claypan ranges from 20 to 40 inches. Beneath this heavy plastic clay layer, at a depth ranging from 26 to 48 inches, is yellowish-brown mottled rather massive sandy clay loam. The lower layers are strongly acid, with a pH value of 5.0 to 5.5. The mottlings are brown, yellow, and red, and in a very few places small iron concretions occur.

Watsonville sandy loam occurs on gently sloping coastal-plain terraces occupied by old alluvial material from sandstone and shale sources, at elevations ranging from 125 to 250 feet. Under natural conditions a low hog-wallow microrelief existed, but, for the most part, this has disappeared through cultivation, although it is still in evidence in the southwestern part of the city of Santa Cruz.

This soil is easily tilled because of its loose, friable surface soil. Surface penetration of water is excellent, and little runoff occurs, but subsoil drainage is very poor. The surface soil does not have a very high water-holding capacity and dries out quickly under cultivation. It contains a fair quantity of organic matter and plant nutrients. The heavy plastic sandy clay subsoil is rather impervious to roots and water, making it a poor soil for deep-rooted crops and trees. Little erosion is evident at the present, although some gullying has taken place in the past. The surface in general is smooth, and the soil in crops is under irrigation.

The largest areas of Watsonville sandy loam are in the vicinity of Santa Cruz and along the coast terraces from Santa Cduz to Davenport. Several small bodies are north of Davenport.

Artichokes and brussels sprouts are the two main crops grown. Artichokes yield about 100 boxes and brussels sprouts 4,000 to 7,000 pounds to the acre. For these crops the land is irrigated frequently, the lower surface soil above the claypan being saturated most of the time. Although these crops are fairly deep rooted and would do better on a

deeper soil, they require the cool foggy weather that prevails in this section. As these crops require a large quantity of nitrogen and other plant nutrients, large quantities of barnyard manure and commercial fertilizers are used. These crops when grown on the lower, more recent alluvial soils yield better but are more subject to frost.

Watsonville loam.—The surface soil of Watsonville loam, to a depth ranging from 18 to 30 inches, is dull grayish-brown friable loam. This layer is heavier and more compact in the lower part, has an irregular blocky or granular structure, and rests on a vesicular layer of sandy loam, light-gray mottled with brown, ranging in thickness from 2 to 6 inches. Underlying this is dull brownish-gray very compact plastic sandy clay having a columnar to prismatic structure. This layer has a thickness of 10 to 20 inches. It grades into slightly less compact yellowish-brown sandy clay mottled with red, yellow, and brown stains. The soil material is acid throughout, being strongly acid in the surface layer, slightly less acid in the gray vesicular layer, and more acid in the lower part of the subsoil and substratum.

Watsonville loam occurs on sloping generally smooth coastal plain terraces at elevations ranging from 75 to 250 feet. In some places, however, the surface originally had a hog-wallow microrelief. The parent materials appear to have been derived mainly from sandstone and shale.

The granular surface layer has a good water-holding capacity, which makes tillage easy. Surface penetration of water is good, but subsoil drainage is very poor, and the heavy subsoil is more or less impervious to both roots and water. The surface soil contains a fair quantity of organic matter. No evident erosion is taking place on this soil at present, although some erosion of the gully type has occurred in the past. The native vegetation consisted of grasses and shrubs, most of which have been destroyed through cultivation.

Watsonville loam occurs on the coastal terraces extending from Watsonville to the northern edge of the county. North from Santa Cruz it occurs in small isolated bodies extending inland a distance of 1 to 1½ miles. Large bodies are northwest of Watsonville and east of Santa Cruz. One small area, northeast of Pinto Lake, which was included with this soil as mapped, has a browner surface soil than typical.

A large part of Watsonville loam northwest and north of Santa Cruz is devoted to artichokes and brussels sprouts. Foggy cool weather, which is necessary in the production of these crops, prevails in this section and is the main reason for growing the crops on this soil. Heavy applications of manure and commercial fertilizers are used. Artichokes yield from 75 to 125 boxes and brussels sprouts from 4,000 to 8,000 pounds an acre. In the section west of Watsonville some grain, truck crops, strawberries, apples, and apricots are produced. Yields are low and of rather poor quality. This soil is not adapted to deep-rooted crops and trees.

Watsonville loam, shallow phase.—The shallow phase of Watsonville loam is identical with typical Watsonville loam in color and development but differs in the depth of its various layers. It is essentially a soil with a dwarfed profile, resting on consolidated shale bedrock at a depth of 18 to 30 inches. The surface soil ranges in

depth from 4 to 8 inches, and the gray vesicular layer above the heavy plastic subsoil ranges from only a faint outline to 2 inches. This shallow soil occurs as higher terracelike areas, which have been eroded to some extent to form a slightly rolling to smooth surface intersected by gullies and ravines. This soil is used only for pasture. It has a native cover of grasses and small shrubs.

Watsonville clay loam.—The upper part of the surface soil of Watsonville clay loam, to a depth ranging from 10 to 24 inches, is dark dull brownish-gray clay loam, which breaks into clods that, when dry, are rather hard and difficult to crush. The lower part of the surface soil is slightly heavier and more compact than the upper part but is permeable to roots and water. It is dull brownish-gray and has a cloddy structure. A thin gray vesicular layer occurs in most places below the more compact surface soil, at a depth of 10 to 24 inches, but in places this layer is lacking. Below this is a dull brownish-gray heavy very compact plastic clay subsoil, the upper 3 or 4 inches of which has a more or less columnar structure, although the material becomes more blocky and cubical with depth. The heavy-textured subsoil is mottled with yellow and red, and in some places it contains small soft iron concretions. Underlying this heavy plastic clay, at a depth of 20 to 40 inches, is yellowish-brown mottled plastic clay, which is massive and very compact. The entire soil mass is slightly to medium acid.

Watsonville clay loam is developed on old alluvial terrace materials having their source mainly in sandstone and shale rocks. The clay loam texture makes tillage somewhat difficult, the soil being sticky when wet and hard when dry. It has good water-holding capacity and the surface penetration of water is good. Although the smooth surface is favorable to irrigation, the subsoil is practically impervious to both roots and water, and subsoil drainage is very slow. No erosion and no deposition of new material are evident on this soil. The native vegetation consisted of grasses and shrubs, but these have been removed through cultivation or pasturing.

The largest areas of Watsonville clay loam occur in the vicinity of Tynan, Kelly, and Pinto Lakes. Smaller bodies are east of Corralitos, west of Aptos, and north of Capitola.

The main crops grown on this soil are grain and beans. A few areas are in apricots, and some are in pasture or stubble. Yields of all crops are low, especially of apricots, which should have a deeper soil, as the heavy subsoil does not allow the roots to penetrate very far. Heavy applications of both barnyard manure and commercial fertilizer are made. In comparison with the loam and sandy loam types of the series, this is a poorer soil because of its heavier and shallower surface soil.

MONTEZUMA SERIES

The Montezuma series comprises soils developed on old transported material of mixed geological origin. They occupy undulating terraces lying from 50 to 100 feet above the valley floor. These soils have fair subdrainage, much of the rainfall is absorbed readily, and very little erosion is evident. The native vegetation consists primarily of grasses.

The surface soils are of dark-gray color and heavy texture and have an "adobe" structure. They are rather friable and of coarse granular

structure. The topmost 2 to 4 inches contain many grass roots. Roots penetrate into the upper part of the subsoils to some extent. The upper subsoil layers are dark and break into large adobe clay blocks having considerable colloidal glazing on their surfaces. The lower subsoil layers are dark gray, have light-gray nodular lime accumulations, and break into small cubical blocks. The substratum consists of light brownish-gray moderately compact heavy-textured sediments that contain less lime than the material above, but they are mottled with yellow, red, and brown spots. This material is more or less massive in appearance and when dug out breaks into blocks.

Montezuma adobe clay.—The surface soil of Montezuma adobe clay is very dark gray clay. When wet, this material is black, plastic, and sticky, but on drying it breaks into an adobe structure, the units of which are hard and have a blocky or granular form. This horizon extends to an average depth of about 12 inches, the topmost 3 inches—the grass root zone—containing a moderate quantity of organic matter. The upper subsoil layer, which occurs at a depth of 12 to 18 inches, is dark-gray adobe clay, very compact with a suggestion of blocky structure when wet and a hard angular cloddy or blocky structure when dry. The lower subsoil layer, beginning at a depth of 28 to 34 inches, is dark-gray moderately compact clay containing light-gray nodular lime accumulations and streaks. This horizon has a prismatic to blocky structure, the units of which break down rather easily under pressure. This is underlain by moderately compact noncalcareous clay, light brownish-gray mottled with yellow, red, and brown stains. The surface soil and the upper subsoil layer, to a depth of 24 to 30 inches, are generally noncalcareous and are neutral in reaction.

Montezuma adobe clay occurs on low terraces having gently sloping to rolling relief.

The heavy clay texture makes tillage somewhat difficult, as the soil is sticky and plastic when wet and is hard and compact when dry. Because of its heavy texture, this soil has a high water-holding capacity, but it gives up water slowly, making available to plants only moderate quantities of water. The terraces on which Montezuma adobe clay occurs are rather narrow and are separated by gullies. Erosion is only slightly active. Subsoil drainage is fairly slow, owing to the heavy texture of the soil. The surface penetration of water and roots is aided greatly by the adobe structure and secondary cracking.

This soil is used almost exclusively for pasture and grain hay. It is fertile, and good yields are produced in favorable seasons. Dry weather, however, reduces yields considerably. The native vegetation on this soil was largely herbaceous, consisting of grass and small brush, but most of it has been cleared for the growing of crops or has disappeared when the land has been used for pasture.

The largest areas of this soil are directly west of Watsonville at a distance of 1 or 2 miles; several small bodies are near Corralitos, and a small body of approximately 80 acres is on the western boundary of Santa Cruz.

MISCELLANEOUS LAND TYPES

Muck and peat.—Muck and peat are highly organic deposits derived chiefly from the accumulation and partial decomposition of a tule-reed vegetation in low marshy or poorly drained areas. All stages of decomposition are represented, from poorly decomposed light-brown fibrous peat to well-decomposed dark-brown mucky organic matter. The stage of decomposition depends largely on the degree of drainage, the areas of more decomposed material having the better drainage. In all places these organic materials are mixed with some mineral soil materials, as mineral materials have washed in from eroded areas on adjacent slopes. The value of the muck and peat areas increases with increase in mineral soil content. The muck and peat deposits range in thickness from 10 inches to several feet and are underlain by gray or bluish-gray heavy silty clay that is highly mottled in many places.

Tillage is exceptionally easy where these soils are well drained; but the areas in general are marshy and have a greatly fluctuating water table. In wet periods in winter they may be flooded, although deep drainage ditches give satisfactory results during the growing season. These ditches support a rank growth of reeds and other plants that obstruct drainage and must be removed at intervals. The lowering of the water table in the areas along the north side of the Pajaro River Valley west of Watsonville has caused subsidence in some of the areas. The rate of sinking is not uniform, however, and presents difficulties in successful tillage and use as pasture.

Areas of muck and peat are used for a wide variety of vegetables, with variable results. When the land was first drained and used for agriculture, large crops of onions, potatoes, and grain were produced; but the yields soon declined and some of the areas reverted to grass. Later it was learned that when beans or some legume was used in the rotation with onions and potatoes, large yields were again produced, but the use of grain in the rotation did not give the same results. At present the chief crops are lettuce and beans used in rotation. Potatoes and onions produce good yields but do not give such large returns as lettuce. Sugar beets grown on this land are low in sugar content. The use of nitrogen-carrying fertilizers gives very good results. Application of barnyard manure or the growing of legumes also are used to add nitrogen to the soil.

The largest area of peat and muck is in Harkins Slough 2½ miles west of Watsonville, and small bodies occur along the north side of the Pajaro River Valley between Harkins Slough and Watsonville. In the smaller creek bottoms many areas have a cover of mineral soil ranging in depth from 15 to 24 inches, especially the small areas adjacent to Watsonville on the north and west. This layer of mineral soil, which is of silty or silty clay texture, greatly increases the agricultural value of the areas. A body of muck and peat, about 80 acres in extent, occurs in Scott Valley on the Felton road 5 miles north of Santa Cruz. It is used for pasture. Grass is the native vegetation where this land has been drained, which causes the cattail-tule association to die out. In general the agricultural value of muck and peat is fairly high.

Marsh.—Marsh consists of low-lying areas that are covered with fresh water a considerable part of the year or have a water table

within a very short distance of the surface. Where the quantity of water is excessive, the land supports a tule-reed or other type of fresh-water vegetation. These areas occupy basins or low areas subject to overflow by drainage water from higher land.

The soil material is composed of dark fine-textured alluvial sediments that have a high organic-matter content and a high degree of mottling. Partial decomposition of the tule-reed vegetation has added considerable peaty material. The agricultural use of these areas is restricted, owing to the excessive moisture; but when drained the soil is valuable for truck crops. Very little of the land has been drained, however, owing to the cost of protecting it from overflow. The principal use of the marsh areas is for bird refuges.

Small areas are 1½ miles northwest of the mouth of the Pajaro River, in the vicinity of Pinto Lake, and about ½ mile southwest of Santa Cruz.

Tidal marsh.—The soil materials of the areas of tidal marsh are stratified or sedimentary, ranging from silty clay to lighter textured material where sand has been washed in. The color ranges from dark brown to dark gray or black, mottled with iron stains, and depends to some extent on the quantity of organic matter included. Some nodules of iron or lime accumulation occur in places. There are remains of clamshells or other shells in most places, and in some they are present in considerable quantities. These marshes occupy positions along the beach, where they are cut off from the ocean by a ridge of dune sand, or at the mouths of small creeks and rivers that empty into the ocean. They are traversed by tidal sloughs, and generally are completely flooded at high tide and partly exposed when the tide is low.

Tidal marsh has a high content of saline salts. It supports a vegetation of saltgrass and pickleweed, which are of no economic value. Some tules grow in the areas having a lower salt content. The probability that the areas of tidal marsh can ever be economically reclaimed is very small, and at present they are of no agricultural value.

A small area of tidal marsh occurs inland from the ridge of dune sand at the mouth of the Pajaro River; one is 3 miles west of the city of Santa Cruz; and larger areas are between Capitola and Santa Cruz.

Coastal beach and dune sand.—Coastal beach and dune sand are so closely associated that only in a few places could they be differentiated on the soil map. Coastal beach consists of brownish-gray or light grayish-brown sand that occurs in narrow areas of shelving beach bordering the ocean. It is subject to considerable reworking by waves and tides. Dune sand is light grayish-brown or brownish-gray sand. Most of the material has been blown inland when dry, has a hummocky or dune relief, is very low in organic matter, and has a very low water-holding capacity. It supports a scrubby growth of shrubs in some places, and in others it is barren of vegetation.

An almost continuous strip of coastal beach extends from the mouth of the Pajaro River north to Santa Cruz. North of Santa Cruz the areas are too narrow to be shown on the soil map. Areas of dune sand are most extensive at the mouth of the Paparo River. It has no agricultural value, although it is used to some extent for recreational purposes. Attempts have been made to stabilize the

movement of sand by planting trees and grasses, the grasses being planted on the side of the dunes facing the ocean and the trees on the more protected side behind the dunes, or away from the ocean.

Riverwash.—Riverwash is a mixture of sand, gravel, and stones, with little or no fine soil material. It is the loose mass of material that occupies stream channels exposed at low water, and it is subject to movement in times of flood. It supports a scattered vegetation of willows and clumps of grass. Its only value is for whatever grazing such a vegetative cover affords. It is limited to a few small narrow areas along the Pajaro River east of Watsonville.

Rough stony land (Holland soil material).—Rough stony land (Holland soil material) consists mainly of outcrops of quartz diorite. The soil mantle on the disintegrating bedrock is very thin and represents material of the Holland series. The bedrock is disintegrated to a depth ranging from 2 to 4 feet. The areas are covered with brush, mostly manzanita, and fourwing saltbush (chamiso), and have no agricultural value. Small areas are on Ben Lomond Mountain, south and east of Bonnie Doon.

Rough stony land (Hugo soil material).—Rough stony land (Hugo soil material) consists of areas of rough land having a shallow mantle of soil material of the Hugo series. Most of the areas are very steep and mountainous, with a slope of 50 percent or more, and they include many rock outcrops and bare spots. Nearly all of this land is along the northeastern county line south of the crest of the Santa Cruz Mountains and Castle Rock Ridge. It covers 20.8 square miles.

This land is of no agricultural value. Madrone, scrubby oaks, manzanita, poison-oak, holly, buckbrush, and other shrubs comprise the vegetation.

MORPHOLOGY AND GENESIS OF SOILS

Soil is the product of forces of weathering and soil development acting on soil materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point depend on the physical and mineralogical composition of the parent soil material, the climate under which the soil material has accumulated and existed since accumulation, the plant and animal life in and on the soil, the relief, or lay of the land, and the length of time the forces of soil development have acted on the soil material. External climate is less important in its effects on soil development than is internal soil climate, which depends not only on temperature, rainfall, and humidity, but on the physical characteristics of the soil or soil material and the relief, which, in turn, strongly influences drainage, aeration, runoff, erosion, and exposure to sun and wind.

The Santa Cruz area borders the Pacific Ocean in the central coast region of California. The soils have been developed under a climatic cycle characteristic of the Pacific coast, with summers that are rainless and winters that have a comparatively high rainfall during December, January, February, and March. The total annual rainfall in the area ranges from about 22 inches in the southeastern part and in the vicinity of Watsonville to about 56 inches in the northeastern part, which is in the Santa Cruz Mountains. The summers have

a higher humidity than in the Great Interior Valley of California. Summer fogs are common and no doubt have had considerable effect in maintaining the vegetation in the summer and the darker color of the soils, as compared with the well-drained soils of the Great Interior Valley. Under these conditions of winter rainfall and summer fog, vegetation thrives throughout most of the year. Seldom does the temperature fall below 30° F.

Under this type of climate, the natural vegetation is dominated by redwood, Douglas-fir, laurel, madrone, tanbark oak, and coast live oak in the deeper soils of the uplands or mountainous section; by ponderosa pine, manzanita, and fourwing saltbush (chamiso) on the shallower soils of the uplands; by brush and coast live oak on the sandier soils of the coastal plain; by grass and brush on the soils of the terraces; and by grasses on the soils of the bottom lands.

Under virgin cover the surface soils normally are fairly dark in the upper 2- to 4-inch layer. After fields are cleared for cultivation or when the cover is removed and the ground left bare for any considerable time, this dark layer is soon dissipated and the soils appear lighter colored. With the exception of the very recently deposited alluvial materials, all the soils of the bottom lands are fairly dark. They normally support a grass cover, and the dark color generally extends to a considerable depth.

All the soils, with the exception of some of the recent alluvial soils in the Pajaro Valley and the Montezuma soils of the older elevated terraces, are acid in reaction. The surface horizons of the normal soils of the uplands or terraces have a pH value (by field test) of 5.0 to 6.0, and the subsoils a pH value of 4.5 to 5.5. Ordinarily, the surface layer of the dark-colored soils has a somewhat higher pH value. The sandier soils have the lowest values, pH 4.5 to 4.8. All the soils, with the exception of the members of the Metz, Salinas, Alviso, and Montezuma series, fall in the pedalferic group. These exceptions mentioned are calcareous somewhere in the profile and therefore fall in the pedocalic group.

The coarse-textured rocks, such as quartz diorite, produce predominantly sandy loam soils, whereas the finer textured rocks, such as shale, give rise to loams or clay loams, and the sandy coastal plain deposits give rise to very sandy soils. The recent and young alluvial soils range in texture from sands to clays.

The soils of the area are identified with five comparatively distinct physiographic belts or divisions (see fig. 2, p. 4). These are soils of the hilly and mountainous uplands, soils of the rolling to hilly and eroded coastal plain, soils of the wind-modified coastal plain, soils of the smooth valleys and coastal terraces, and soils of the gently sloping alluvial fans and stream bottoms.

The soils of the hilly and mountainous upland areas have a considerable range in color and in mineralogical composition. They are developed in place on consolidated bedrock materials that differ in geological character and in mineralogical composition, and the differences are reflected in the soil materials. Many of the slopes are steep and are subject to erosion when the natural vegetation is removed.

The soils of this group developed on quartz diorite bedrock include the brown soils of the Holland series and the darker colored Sheridan soils. The Cayucos soils consist of dark grayish-brown or dark brownish-gray soils develcoped on shale or sandstone bedrock; and

the Santa Lucia soils are dark grayish-brown soils developed on siliceous shale bedrock. The Felton soils are brown and are developed on a parent bedrock of mica schist. The Arnold soils are gray and are developed on a softer consolidated light-gray sandstone parent material. The Hugo soils are grayish brown and are developed on a shale or sandstone parent material.

Under virgin conditions all these soils of the uplands have a dark-colored organic layer in the topmost 2 or 3 inches, covered by leaves and other litter. They have slightly heavier textured and slightly compact subsoils as evidence of a young or immaturely developed profile. The surface layers have a pH value of 4.5 to 5.5 or slightly higher in the darker colored soils.

The soils of the upland coastal plain areas are represented by the soils of the Tierra and Moro Cojo series, which occupy rolling to hilly and in many places eroded upland terraces. The Moro Cojo soils are developed on soft sandstonelike material. The surface soils are brown and are generally very sandy, the sand grains being well rounded and having a rust-colored coating that can be rubbed off. The surface soils are medium acid. The subsoils, beginning at a depth of 12 to 24 inches, are somewhat yellower or redder, have a slight accumulation of colloidal material, and are slightly compact. In the areas where the Moro Cojo soils are cultivated or where the natural vegetation has been removed, erosion is active.

The surface soils of the Tierra soils are dull grayish brown or dull brownish gray. They change abruptly to brownish-gray or dark grayish-brown compact sandy clay. This breaks to a columnar structure when dry. The columns are somewhat rounded on the tops and are covered with light-gray siliceous vesicular sandy material to a depth of ½ inch to 2 inches. The top part of the clay layer contains considerable dark colloidal staining on the faces of the structural aggregates. The lower part of the subsoil is lighter colored than the upper part, compact, and generally highly mottled with iron stains. When dry it breaks to a small blocky or cubical structure. The parent material consists of semiconsolidated marine sediments consisting of brown or yellow sandy clay loam or sandy clay. The material in all the horizons of the Tierra soils is acid in reaction.

The soils of the alluvial fans and bottoms consist of alluvial deposits that have been but little modified since deposition. They have a wide range in color, mineralogical composition, lime content, and drainage. The chief characteristics of their profiles are due to the stratification of the soil materials. The soils included in this group are members of the Alviso, Salinas, Soquel, Botella, Corralitos, Pajaro, Metz, and Laguna series, with some of which are associated small areas of muck and peat. The Alviso soils are brownish gray, calcareous throughout the soil mass, and poorly drained. They occupy low flat tidelands and have subsoils highly mottled with iron stains. They are typical saline soils. The Salinas soils, lying just above the Alviso soils, have dark grayish-brown moderately to slightly alkaline surface soils and slightly compact and calcareous subsoils. These are young alluvial soils derived from mixed geological materials. The Botella soils are similar to the Salinas soils, but they are mildly acid and are developed mainly from shales and

sandstones. The Metz soils are lighter colored, calcareous, recent alluvial soils developed from mixed sources.

All the soils of the Corralitos, Pajaro, Soquel, and Laguna series are formed from outwash from sedimentary rocks, and all are moderately to strongly acid in reaction throughout. The Corralitos soils have brown surface soils and subsoils of the same or lighter color and texture. The Pajaro soils are characterized by grayish-brown or dull-brown surface soils and slightly compact slightly heavier textured subsoils mottled with yellow and brown. Occurring in mountain basins, such as Big Basin and Little Basin, these soils were formed under poorer drainage than prevails at present. Members of the Soquel series have dark brownish-gray or dark grayish-brown surface soils underlain by browner loose friable material, which makes up the subsoils and substrata. The Laguna soils have light-gray or brownish-gray surface soils and gray or yellowish-gray loose or friable subsoils. The parent material from which the Laguna soils have developed is eroded from soft sandstone. These soils occupy sloping alluvial fans immediately below the residual soils of the Arnold series.

Soils developed on wind-modified or aeolian materials of the coastal plain terrace are in the Marina and Elkhorn series. The Marina soils represent the young soils of this group and have brown or rich-brown surface soils. The subsoils have about the same texture as the surface soils, but they are slightly compact and are lighter brown. The members of the Elkhorn series have surface soils of about the same color but have subsoils of moderate compaction, have a colloidal accumulation, and are somewhat heavier textured than the surface soils. They are mottled with iron stains and contain a few hard pellets. The Elkhorn soils occupy smoother areas than the Marina soils and represent a more advanced stage in development of the Marina soil material. Both the Marina and the Elkhorn soils are acid throughout, having a pH value of 4.5 to 5.8.

The soils of the older valley and coastal terraces include members of the Ben Lomond, Pinto, Watsonville, Lockwood, and Montezuma series. The Ben Lomond soils have the least developed profile of the soils of this group. They have brown surface soils and brown or grayish-brown slightly to moderately compact subsoils that are slightly heavier textured than the surface soils. The parent soil material is of mixed mineralogical composition. The entire soil mass is acid.

The members of the Pinto series have brown or reddish-brown strongly acid surface soils with a pH value of approximately 5.0. The subsoils are reddish brown or brownish red, moderately compact, and heavier textured than the surface soils. The subsoils break to a fairly hard blocky structure when dry. They have considerable yellow and brown mottling and soft weathered fragments of parent rock in the subsoils, which are moderately acid (pH 5.0 to 5.7). The substratum consists of yellowish-brown moderately compact gravelly loam or gravelly clay loam. The gravel is fairly soft and is derived chiefly from sedimentary rocks. This material has a pH value of approximately 6.0. The Pinto soils are associated with the related Watsonville soils but are browner, lack the light-gray sandy subsoil layer, do not have so heavy a texture, and do not have such compact subsoils. Normally they are somewhat better drained than the Watsonville soils.

The soils of the Watsonville series have surface soils that are dark grayish brown and slightly granular in structure. They have a pH value between 5.0 and 5.3. A subsurface layer of gray vesicular siliceous material, highly mottled with brown stains, is very characteristic of the soil in this area. It rests on dull brownish-gray very compact sandy clay that breaks with a columnar structure in the topmost 3 or 4 inches. The tops of the columns are slightly rounded in place. The lower part of the clay subsoil breaks into hard angular blocks. The substratum in most places is yellowish-brown compact highly mottled sandy clay. The pH value of the subsoil ranges from about 4.5 to 5.5, and that of the substratum is about 5.5 or less. The Watsonville soils have pronounced solonetzlike profiles and are developed on old alluvial-valley or coastal-plain materials.

Members of the Lockwood series have surface soils that are dark brownish gray or dark grayish brown. They are mildly to moderately acid. The upper subsoil layers are gray and moderately compact, whereas the lower subsoil layers are much more compact and contain much more colloidal clay. Some gravel and angular stones occur throughout the soil mass, the quantity generally increasing with depth. The substratum is a brown material composed mostly of gravel and stones with a large proportion of angular fragments of Monterey shale. The reaction of this lower material is medium acid. Soils of the Lockwood series occur chiefly on smooth sloping terraces along the coastal plain just below the residual soils of the Santa Lucia series. Their profiles have less pronounced development than those of the Watsonville soils, and they are derived from a different kind of parent material.

The soils of the Montezuma series have dark-gray to black surface soils. They have a typical adobe structure and break down to large blocks ranging from 8 to 18 inches in diameter. On drying and shrinking, the large blocks break into angular clods and small fragments. The reaction of the surface soils is neutral or very slightly acid. The topmost 2 or 3 inches of the surface soils is more permeated with roots and is much more friable and more granulated than the material below. The upper subsoil layers consist of dark-gray very compact adobe clay. The lower subsoil layers are dark-gray moderately compact clay containing lime in the form of soft dark-gray nodular concretions, and to some extent it is disseminated throughout the material. When dry the lower subsoil layers have a prismatic or blocky structure. The substratum is light brownish-gray moderately compact noncalcareous clay mottled with red, yellow, or brown. These soils occupy low terraces lying from 25 to 75 feet above sea level. They are entirely different from any other soils in this area in respect to reaction. In many respects these soils have the color and profile characteristics of Chernozems.

RATINGS OF SOILS AS TO THEIR SUITABILITY FOR CROPPING

In table 8 the soil types and phases of the Santa Cruz area are given percentage ratings and grades by means of the Storie soil index (*10*). For the convenience of the reader, the soils listed in table 8 according to rating and grade are arranged alphabetically in table 9.

TABLE 8.—*Rating and grades of the soils of the Santa Cruz area, Calif., listed in the order of their suitability for cropping, the best soils first*

Soil	Rating	Grade
	Percent	
Metz fine sandy loam, shallow phase (over Salinas soil material)	95	
Metz silt loam, shallow phase (over Salinas soil material)	95	
Soquel loam	95	
Pajaro loam	90	
Pajaro sandy loam	90	
Pajaro clay loam	90	
Metz silt loam	90	1
Soquel sandy loam	90	
Salinas silty clay loam	87	
Botella silty clay loam	86	
Corralitos sandy loam	85	
Salinas clay loam	81	
Botella clay loam	81	
Soquel silty clay loam	81	
Metz fine sandy loam	80	
Salinas silty clay	76	
Ben Lomond loam	76	
Muck and peat	70	
Botella clay	66	2
Lockwood loam	64	
Cayucos loam	63	
Soquel loam, stony phase	63	
Sheridan loam	56	
Pinto loam	54	
Cayucos clay loam	54	
Elkhorn loam	54	
Hugo loam	54	
Corralitos sand	54	
Corralitos sand, shallow phase (over Botella soil material)	54	
Pinto sandy loam	51	
Watsonville sandy loam	51	
Cayucos sandy loam	50	3
Sheridan sandy loam	50	
Hugo clay loam	48	
Holland fine sandy loam	48	
Felton loam	48	
Hugo fine sandy loam	45	
Elkhorn sandy loam	45	
Watsonville loam	45	
Pinto loam, compact-subsoil phase	43	
Holland sandy loam	42	
Montezuma adobe clay	42	
Marina sand	42	3
Pinto clay loam	40	
Moro Cojo sandy loam	38	
Watsonville clay loam	38	
Hugo sandy loam	36	
Laguna fine sand	36	
Moro Cojo loamy sand	33	
Ben Lomond loam, stony phase	33	4
Santa Lucia clay loam	32	
Santa Lucia clay	32	
Tierra loam	32	
Tierra clay loam	31	
Moro Cojo gravelly loam	29	
Watsonville loam, shallow phase	24	
Arnold sand	19	
Hugo loam, steep phase	18	
Hugo fine sandy loam steep phase	15	
Cayucos loam, steep phase	15	
Hugo sandy loam, steep phase	14	
Cayucos clay loam, steep phase	14	
Sheridan loam, steep phase	14	
Hugo clay loam, steep phase	13	
Santa Lucia clay loam, shallow phase	13	5
Sheridan sandy loam, steep phase	13	
Holland fine sandy loam, steep phase	12	
Holland sandy loam, steep phase	11	
Rough stony land (Holland soil material)	11	
Felton loam, steep phase	10	
Hugo loam, shallow phase	8	
Santa Lucia clay loam, steep phase	8	
Felton stony sandy loam	8	
Santa Lucia clay, steep phase	7	
Alviso clay	7	
Marsh	5	6
Rough stony land (Hugo soil material)	3	
Arnold sand, steep phase	3	
Tidal marsh	3	
Coastal beach and dune sand	3	
Riverwash	3	

Index ratings are obtained by weighing such soil characteristics as depth, texture, and density of the surface soil and subsoil, acidity, salt ("alkali") content, drainage, erosion, and slope, and by assigning percentages to those characteristics that appear to determine the suitability of the soil for the growing of crops. The most favorable or ideal condition of each of these individual characteristics is rated at 100 percent, and each soil type is given a comparative rating for this characteristic. These ratings are multiplied to produce the soil index rating. This soil index rating is based on soil characteristics alone; local weather conditions, rainfall, temperature, or availability of irrigation water are not considered. This rating is a comparison of these soils with one another and with other soils of California, irrespective of location. It should be understood that soil types are not uniform and that ratings do not fit perfectly every part of each soil type area. The rating given is for the typical or dominant condition.

TABLE 9.—*Alphabetical list of the soils of the Santa Cruz area, Calif., showing rating and grades according to their suitability for cropping*

Soil	Rating	Grade
	Percent	
Alviso clay	7	6
Arnold sand	19	5
Arnold sand, steep phase	3	6
Ben Lomond loam	76	2
Ben Lomond loam, stony phase	33	4
Botella clay	66	2
Botella clay loam	81	1
Botella silty clay loam	86	1
Cayucos clay loam	54	3
Cayucos clay loam, steep phase	14	5
Cayucos loam	63	2
Cayucos loam, steep phase	15	5
Cayucos sandy loam	50	3
Coastal beach and dune sand	3	6
Corralitos sand	54	3
Corralitos sand, shallow phase (over Botella soil material)	54	3
Corralitos sandy loam	85	1
Elkhorn sandy loam	45	3
Elkhorn loam	54	3
Felton loam	48	3
Felton loam, steep phase	10	5
Felton stony sandy loam	8	6
Holland fine sandy loam	48	3
Holland fine sandy loam, steep phase	12	5
Holland sandy loam	42	3
Holland sandy loam, steep phase	11	5
Hugo clay loam	48	3
Hugo clay loam, steep phase	13	5
Hugo fine sandy loam	45	3
Hugo fine sandy loam, steep phase	15	5
Hugo loam	54	3
Hugo loam, shallow phase	8	6
Hugo loam, steep phase	18	5
Hugo sandy loam	36	4
Hugo sandy loam, steep phase	14	5
Laguna fine sand	36	4
Lockwood loam	64	2
Marina sand	42	3
Marsh	5	6
Metz fine sandy loam	80	1
Metz fine sandy loam, shallow phase (over Salinas soil material)	95	1
Metz silt loam	90	1
Metz silt loam, shallow phase (over Salinas soil material)	95	1
Montezuma adobe clay	42	3
Moro Cojo gravelly loam	29	4
Moro Cojo loamy sand	33	4
Moro Cojo sandy loam	38	4
Muck and peat	70	2
Pajaro clay loam	90	1
Pajaro loam	90	1
Pajaro sandy loam	90	1
Pinto clay loam	40	3
Pinto loam	54	3
Pinto loam, compact-subsoil phase	43	3
Pinto sandy loam	51	3
Riverwash	3	6
Rough stony land (Holland soil material)	11	5
Rough stony land (Hugo soil material)	3	6
Salinas clay loam	81	1
Salinas silty clay	76	2
Salinas silty clay loam	87	1
Santa Lucia clay	32	4
Santa Lucia clay, steep phase	7	6
Santa Lucia clay loam	32	4
Santa Lucia clay loam, shallow phase	13	5
Santa Lucia clay loam, steep phase	8	6
Sheridan loam	56	3
Sheridan loam, steep phase	14	5
Sheridan sandy loam	50	3
Sheridan sandy loam, steep phase	13	5
Soquel loam	95	1
Soquel loam, stony phase	63	2
Soquel sandy loam	90	1
Soquel silty clay loam	81	1
Tidal marsh	3	6
Tierra clay loam	31	4
Tierra loam	32	4
Watsonville clay loam	38	4
Watsonville loam	45	3
Watsonville loam, shallow phase	24	4
Watsonville sandy loam	51	3

On the basis of the index ratings, the soils are placed in six grades. Soils having an index rating of 80 to 100 percent are placed in grade 1. The soils of this grade are considered to be of excellent quality and suitable for a wide range of crops. Yields are above the average. Grade 2 soils (index ratings between 60 and 79 percent) are of good quality and suitable for most crops. Grade 3 soils (index ratings between 40 and 59 percent) are somewhat limited in their uses by unfavorable texture, by shallowness, or by other undesirable soil factors. Grade 4 soils (index ratings between 20 and 39 percent) are suitable for fewer crops and produce low yields, compared with the higher rated soils. Certain soils, such as Watsonville loam, shallow phase, that have a relatively low rating might successfully produce a special crop like beans and yet not be suited to a range of crops. Grade 5 soils (index ratings between 10 and 19 percent) are generally of very poor quality for any cultivated crop because of shallowness, stoniness, or steep slopes. Grade 6 soils (index ratings of less than 10 percent) are nonarable because of shallowness, very steep slopes, or other limiting factors. Tidal marsh, coastal beach and dune sand, and riverwash are land types also included in this grade.

LABORATORY STUDIES[9]

Mechanical analyses of all the samples of surface soils were made by a proximate method in which the air-dried soils were screened through a 2-millimeter sieve. A subsample of the screened soil was shaken in distilled water with ammonium hydroxide as a dispersant and then washed through a 300-mesh sieve to remove the sands, which are reported as total sands. The silt and clay suspension that passed through the sieve was made up to volume, allowed to stand, and sampled by the pipette at the proper time intervals to give effective maximum diameters of coarse silt at 50 microns, fine silt or coarse clay at 5 microns, and fine clay at 2 microns.

The samples from 13 soil profiles were analyzed by the more complete dispersal method whereby the soil was pretreated with hydrogen peroxide and hydrochloric acid to remove organic matter and carbonates, the subsequent manipulation being essentially the same as that just described. The results of these analyses are given in table 10.

A comparison of the results obtained by this complete dispersion method and the proximate method showed very minor differences, but generally the amount of clay was lower by the proximate method. This is particularly true of the soils having the higher organic matter content or those types of pedocalic nature. The content of either lime or organic matter seems to mask the content of clay and in field examinations gives an impression of a coarser texture than the mechanical analyses indicate.

The analyses of the horizon samples of 13 soils bring out certain features in the stage or degree in development of the various soils. The soils of the bottom lands, such as Soquel silty clay loam, generally do not have so much colloidal clay in their subsoils as Pinto loam and Watsonville loam, which are developed on older terrace materials. The soils of the uplands do not have any marked accumulation of subsoil clay.

The moisture equivalents were determined by the standard method, in which 30 gm. of saturated soil is subjected to a force of 1,000 times gravity in a centrifuge. The moisture equivalents are reported in percentage of moisture calculated on the basis of oven-dry soil. They represent approximately the normal field moisture capacity, or the amount of water held in the soil after a heavy rain or irrigation where downward drainage is free and uninterrupted. Those soils classed as sands in this area have a moisture equivalent between 4 and 7 percent, those classed in the sandy loam group between 8 and 15 percent, those in the loam group between 15 and 24 percent, those in the clay loam group between 24 and 29 percent, and the silty clays and clays between 29 and 45 percent.

The reaction of all the samples was determined by the colorimetric method. Carbonates were determined in the soils having a pH value of about 7.0 by means of an adaptation of the McMiller method whereby a 10-gm. sample of oven-dry soil, previously passed through a 2 mm. sieve, is placed in a flask and standardized hydrochloric acid added until effervescence ceases. The soil solution is filtered and washed until the filtrate is free of acid; then it is titrated with standardized sodium hydroxide, using phenolphthalein as an indicator.

[9] Contributed by R. E. Storie, division of soil technology, University of California.

TABLE 10.—*Mechanical analyses*[1] *of samples of 13 soils from the Santa Cruz area, Calif*

Soil type and sample No.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Coarse clay, 5–2μ	Ultra clay, 2μ+
Pinto loam	*Inches*								
578807	0– 9	0 9	4 4	-------	28 5	15 9	31 0	4 3	15 7
578808	9–17	8	4 4	6 8	20 9	14 4	28 8	4 3	19 7
578809	17–26	4	4 5	5 6	19.8	13 5	25 5	5 3	26 1
578810	26–44	1 0	3 8	6 0	20 5	13 4	22 6	4 4	28 0
578811	44–70	8	4 2	4.7	17 9	16 0	25 8	6 6	23 7
Botella clay loam									
578812	0–18	1	5	6	5 1	6 2	44 5	10 7	32 9
578813	18–36	0	5	1 2	6 2	6 5	34 6	11.2	39.6
578814	36–54	0	6	7	4 8	10 7	62 2	8 2	13 9
Marina sand									
578827	0–18	0	8 8	27 3	47 6	7 0	3 4	.9	5.2
578828	18–40	1	8 1	26 5	47 5	7 9	4 4	.3	5 4
578829	49–72	0	8 8	25 8	54 4	4 6	2 2	.7	3.5
Elkhorn sandy loam (older profile):									
578830	0–10	2	11 7	23 3	37 3	3 7	10 2	3 3	11.5
578831	10–22	4	5 0	12 6	27 0	7.8	23 4	2 7	21.6
578832	22–37	3	5 3	13 4	27 6	5.0	19 8	2.5	26.5
578833	37–63	1	7 7	14.4	31 8	4 2	14 9	2.0	26.3
Elkhorn sandy loam (younger profile):									
578830A	0–14	4	5 9	13 5	28 3	6.7	25.1	4 4	15 2
578831A	14–24	.1	9 8	21 7	36 9	4 0	11.6	2 1	14 1
578832A	24–44	1	9 5	21 5	38 7	3 5	10.9	2.2	14 1
578833A	44–72	1	18 4	27.9	36 6	2 7	5.0	1.8	7 7
Pinto sandy loam									
578834	0–14	1 2	9 7	22 8	37 6	7 0	9 1	1 3	11 2
578835	14–25	7.9	16 6	18 3	26 9	3.4	6 7	1.0	19.2
578836	25–48	2 4	14 0	21 3	45.5	6.5	3 4	1.1	5.3
Sheridan sandy loam									
578857	0–32	9 8	11 7	5 2	14 1	12 8	27.5	5 0	14.1
578858	32–50	17 9	18 2	8 3	15 6	11 6	16.7	2 8	8.9
578859 [2]	50–60	22 1	25 5	8 7	17 7	7 3	11.3	1.8	5 9
Felton loam:									
578863	0–16	7 4	13 6	6 7	12 8	10 8	25.6	7 3	16.5
578864	16–36	2 8	11 2	6 5	19 9	9 9	22.4	6 2	21.8
578865 [3]	36–50	4 3	17 9	10 1	18 9	12 3	18.9	6.2	12.5
Hugo loam									
578886	0–13	.1	2 0	3 3	29 1	20 0	29 3	4.6	12.3
578887	13–40	1	2 0	4 4	26 6	21 9	27 8	4 4	13 1
578888 [2]	40–50	.2	4 6	7 5	32 6	16 9	23 9	3.8	10.1
Pajaro loam:									
578894	0–13	.2	1 0	1 2	7 0	26 9	43 0	5 8	15 8
578895	13–36	.1	7	7	6 6	26 2	42 7	4 9	18 6
578896	36–48	9	1 9	1 4	5 9	22 4	37 3	7 0	24.9
578897	48–50	1 3	2 5	1 3	6.3	20 9	35 9	3 4	29.7
Tierra loam:									
5788103	0– 7	5 1	8 3	7 6	17 1	14 4	29.5	3 5	13 5
5788104	7–16	5 0	8 2	6 1	18 6	15 6	29 4	3.6	14 2
5788105	16–18	5 9	7 6	7 6	18 5	14 0	29.5	3 7	13.7
5788106	18–24	3 1	6.3	5 1	16 3	10 7	22 0	2 7	35.2
5788107	24–36	(4)	(4)	(4)	(4)	(4)	24 8	3 1	37.1
5788108	36–80	5 0	7 8	7 1	17 3	13 8	20 3	2 5	26.6
Watsonville loam									
5788112	0–10	1 2	3 7	5.4	21 1	14 3	33 2	4 5	15.4
5788113	10–20	9	4 1	4 8	20 8	15 7	32 7	4 7	17 5
5788114	20–24	1 2	4 6	7 6	22 8	11 1	32 7	5 3	14 9
5788115	24–37	.5	2 0	3 2	12 1	7 1	20.8	4 6	40.5
5788116	37–50	1 0	3 6	6 4	19.9	10 7	24.0	3 6	31 9
Watsonville sandy loam									
5788125	0–19	7	8 9	11 3	38 9	10 0	17 9	3 0	9 7
5788126	19–22	7	9 4	10 5	39 4	9 2	14.0	1 9	14 4
5788127	22–28	.5	6 5	11 6	36.5	5 9	10.7	2 9	25 6
5788128	28–40	2 7	14 7	13.1	38 0	3.9	7 4	3.0	17.7

[1] International method [2] Bedrock [3] Sandstone [4] Sands lost.

The calcium carbonate content of the Metz and Salinas soils is fairly high. The subsoil of Montezuma adobe clay has a content of about 6 percent. All the other soils of the terraces and uplands are low in carbonates.

Moisture equivalents, pH values, and carbonates are reported in table 11.

TABLE 11.—*Moisture equivalents, pH, values, and carbonates in soils of the Santa Cruz area, Calif.*

Soil type and sample No.	Depth	Moisture equivalents	pH [1]	Carbonates [2]
Metz fine sandy loam: [3]	*Inches*			
578801	0-12	11.01	7.3	2.76
578802	12-72	9.74	7.5	1.45
Metz silt loam:				
578803	0-16	23.60	6.6	----------
578804	16-72	19.46	7.4	4.42
Soquel loam:				
578805	0-16	23.86	6.8	----------
578806	16-72	24.49	6.6	----------
Pinto loam:				
578807	0-9	15.46	4.9	----------
578808	9-17	17.29	4.9	----------
578809	17-26	19.28	4.8	----------
578810	26-44	21.18	5.2	----------
578811	44-70	22.06	4.5	----------
Botella clay loam:				
578812	0-18	29.91	7.0	----------
578813	18-36	30.17	6.6	----------
578814	36-54	24.25	6.8	----------
Salinas silty clay loam				
578815	0-14	30.85	7.2	8.02
578816	14-30	33.59	7.0	5.10
578817	30-60	30.36	7.2	2.72
Moro Cojò loamy sand				
578818	0-18	10.81	5.6	----------
578819	18-40	14.41	6.2	----------
578820 [4]	40-90	12.38	6.1	----------
Botella silty clay loam:				
578821	0-24	25.39	6.6	----------
578822	24-34	31.14	6.6	----------
578823	34-65	30.10	7.0	----------
Marina sand:				
578827	0-18	5.85	5.5	----------
578828	18-49	4.35	6.0	----------
578829	49-72	3.43	6.2	----------
Elkhorn sandy loam (older profile)				
578830	0-10	14.34	5.2	----------
578831	10-22	14.72	5.9	----------
578832	22-37	16.19	6.2	----------
578833	37-63	17.00	6.2	----------
Elkhorn sandy loam (younger profile)				
578830A	0-14	8.99	5.1	----------
578831A	14-24	8.96	5.8	----------
578832A	24-44	9.39	5.8	----------
578833A	44-72	6.73	6.0	----------
Pinto sandy loam:				
578834	0-14	9.50	5.6	----------
578835	14-25	14.96	5.8	----------
578836	25-48	6.37	6.6	----------
Moro Cojo sandy loam:				
578837	0-18	13.70	5.8	----------
578838	18-45	12.14	5.6	----------
578839	45-60	13.42	5.3	----------
578840	60-72	17.30	5.4	----------
Moro Cojo gravelly loam:				
578841	0-15	13.81	6.2	----------
578842	15-30	12.12	5.8	----------
578843	30-50	11.33	6.4	----------
Soquel sandy loam:				
578844	0-14	15.26	6.2	----------
578845	14-72	7.11	6.5	----------
Corralitos sand				
578846	0-12	5.97	6.2	----------
578847	12-72	6.11	6.5	----------
Pinto clay loam:				
578848	0-12	17.38	5.5	----------
578849	12-24	17.19	5.6	----------
578850	24-44	19.66	5.9	----------
578851	44-64	23.81	5.3	----------
Santa Lucia clay loam				
578852	0-9	31.60	5.0	----------
578853	9-24	32.46	4.8	----------
578854 [5]	24-30	------------	4.6	----------
Laguna fine sand:				
578855	0-12	7.20	6.2	----------
578856	12-72	5.84	5.5	----------
Sheridan sandy loam:				
578857	0-32	21.61	5.9	----------
578858	32-50	18.49	5.7	----------
578859 [5]	50-60	15.90	6.2	----------

See footnotes at end of table.

TABLE 11.—*Moisture equivalents, pH values, and carbonates in soils of the Santa Cruz area, Calif.*—Continued

Soil type and sample No.	Depth	Moisture equivalents	pH	Carbonates
	Inches			
Sheridan loam:				
578860	0-20	26.85	5.7	----------
578861	20-45	22.49	5.7	----------
578862 [5]	45-55	10.32	5.6	----------
Felton loam:				
578863	0-16	26.95	5.8	----------
578864	16-36	28.85	5.6	----------
578865 [5]	36-50	26.27	5.1	----------
Felton stony sandy loam				
578866	0- 4	19.97	4.7	----------
578867	4-19	30.66	5.0	----------
578868 [5]	19-24	14.05	5.0	----------
Lockwood loam:				
578869	0-14	19.46	6.0	----------
578870	14-27	18.89	5.8	----------
578871	27-48	31.83	5.7	----------
578872	48-72	22.08	5.7	----------
Holland sandy loam.				
578873	0-15	27.33	5.3	----------
578874	15-44	25.01	5.6	----------
578875 [5]	44-55	20.14	5.4	----------
Arnold sand:				
578876	0-10	4.64	5.7	----------
578877 [6]	10-36	2.58	6.2	----------
Cayucos clay loam				
578878	0-15	28.99	5.7	----------
578879	15-44	22.91	6.1	----------
578880 [6]	44-54	27.33	6.3	----------
Hugo sandy loam				
578881	0-10	11.76	5.7	----------
578882	10-30	12.39	5.8	----------
Hugo clay loam:				
578883	0-14	24.99	6.2	----------
578884	14-42	24.19	6.0	----------
578885 [5]	42+	----------	5.2	----------
Hugo loam:				
578886	0-13	17.87	6.0	----------
578887	13-40	17.74	5.6	----------
578888 [6]	40-50	15.64	5.8	----------
Corralitos sandy loam				
578889	0-18	11.74	5.5	----------
578890	18-72	12.38	5.6	----------
Ben Lomond loam				
578891	0-15	19.22	6.1	----------
578892	15-42	17.19	5.8	----------
578893	42-60	16.09	5.8	----------
Pajaro loam:				
578894	0-13	23.81	5.8	----------
578895	13-36	24.26	5.2	----------
578896	36-48	28.59	4.5	----------
578897	48-60	20.91	4.6	----------
Cayucos sandy loam:				
578898	0-14	19.49	4.7	----------
578899	14-40	19.30	5.5	----------
5788100 [6]	40-60	12.71	5.6	----------
Soquel silty clay loam:				
5788101	0-28	29.25	7.0	----------
5788102	28-60	20.22	6.7	----------
Tierra loam:				
5788103	0- 7	16.30	5.4	----------
5788104	7-16	15.93	5.4	----------
5788105	16-18	16.03	5.8	----------
5788106	18-24	29.75	6.5	----------
5788107	24-36	[7] 40.76 [8] 34.02	6.7	----------
5788108	38-80	[7] 35.14 [8] 29.26	8.2	1.10
Santa Lucia clay				
5788109	0-16	45.31	5.4	----------
5788110	16-28	41.31	5.3	----------
5788111 [5]	28-38	40.78	4.7	----------
Watsonville loam				
5788112	0-10	15.99	5.3	----------
5788113	10-20	16.72	5.5	----------
5788114	20-24	15.66	6.2	----------
5788115	24-37	[7] 38.95 [8] 36.66 [8] 29.78	5.2	----------

See footnotes at end of table.

TABLE 11.—*Moisture equivalents, pH values, and carbonates in soils of the Santa Cruz area, Calif.*—Continued

Soil type and sample No.	Depth	Moisture equivalents	pH	Carbonates
	Inches			
Watsonville loam—Continued.				
5788116	37–50	[7] 35.22 [8] 28.20 [8] 26.98	5.2	----------
Montezuma adobe clay:				
5788117	0–12	37.40	6.6	----------
5788118	12–30	45.06	6.9	----------
5788119	30–42	[7] 55.77 [8] 50.72 [8] 47.10	8.2	6.36
5788120	42–60	[7] 46.88 [8] 42.05 [8] 38.16	5.8	.88
Tierra loam:				
5788121	0–8	20.67	5.3	----------
5788122	8–16	20.17	5.2	----------
5788123	16–38	24.22	4.7	----------
5788124	38–48	25.94	4.4	----------
Watsonville sandy loam:				
5788125	0–19	10.70	5.1	----------
5788126	19–22	13.32	5.2	----------
5788127	22–28	21.63	5.3	----------
5788128	28–40	16.09	5.5	----------
Salinas silty clay:				
5788129	0–15	33.66	7.0	8.65
5788130	15–25	38.24	6.8	10.15
5788131	25–34	36.41	7.0	7.28
5788132	34–65	28.87	8.2	4.00
Pajaro clay loam				
5788133	0–13	23.61	6.3	----------
5788134	13–23	22.71	6.4	----------
5788135	23–36	19.79	6.5	----------
5788136	36–60	15.32	6.7	----------
Pajaro sandy loam				
5788137	0–15	16.34	5.6	----------
5788138	15–28	12.29	6.5	----------
5788139	28–42	17.77	6.7	----------
5788140	42–72	6.87	7.0	----------
Watsonville clay loam				
5788141	0–11	16.74	6.3	----------
5788142	11–16	15.80	5.5	----------
5788143	16–32	21.66	4.8	----------
5788144	32–45	15.56	5.7	----------
5788145	45–60	16.35	5.9	----------
Botella clay:				
5788146	0–12	32.19	6.9	----------
5788147	12–34	33.81	6.4	----------
5788148	34–60	23.17	6.7	----------
Alviso clay:				
5788149	0–7	38.63	8.2	6.98
5788150	7–60	[7] 53.58 [8] 45.77	6.8	----------
Salinas silty clay loam				
5788151	0–22	30.00	6.7	----------
5788152	22–40	33.20	6.8	----------
5788153	40–70	22.77	8.2	4.27
Holland fine sandy loam				
5788154	0–10	32.36	5.5	----------
5788155	10–25	29.79	5.9	----------
5788156	25–40	27.42	5.5	----------
5788157 [9]	40–50	28.78	5.7	----------
Cayucos loam:				
5788158	0–15	21.46	6.0	----------
5788159	15–33	19.40	5.3	----------
5788160 [10]	33–58	27.31	4.8	----------
5788161 [5]	58–72	30.41	5.2	----------
Hugo fine sandy loam				
5788162	0–14	13.15	4.8	----------
5788163	14–30	14.78	4.8	----------
5788164 [5]	40–30	----------	4.8	----------

[1] By colorimetric determination.
[2] By the McMiller method.
[3] Stratified.
[4] Substratum.
[5] Bedrock.
[6] Sandstone.
[7] Water standing on top of sample or extreme wetness of sample necessitating centrifuging again with wax paper or absorbent.
[8] Centrifuged with soil cups lined with wax paper to facilitate drainage.
[9] Diorite.
[10] Shale.

SUMMARY

The Santa Cruz area is situated along the central coast of California about 60 miles south of San Francisco. It comprises Santa Cruz County, a small area in the northern part of Monterey County, and about 3 square miles east of Aromas in San Benito County. The area comprises 456 square miles, or 291,840 acres.

The climate is mild. The winters are wet and mild, and the summers are rainless and of even temperature. The average rainfall at Watsonville is 27.17 inches. Temperatures of less than 32° F. very rarely occur. Summer fogs are common along the coast.

About 69 percent of the area is composed of an upland hilly and mountainous section that is, for the most part, wooded or forested. Less than 10 percent of this land has been cleared and put in cultivated crops. The soils of the hilly and mountainous section have been developed in place from the underlying bedrock, which lies from a few inches to 4 feet below the surface. The group comprises soils of the Hugo, Cayucos, Santa Lucia, Arnold, Holland, Sheridan, and Felton series. All these soils are acid and are erodible on slopes. The cleared areas are planted largely to apples, prunes, plums, pears, or grapes.

The Hugo soils have a considerable range in texture, depth, and slope. The soils are grayish brown and rest on parent sandstone or shale bedrock. The Cayucos soils are similar to the Hugo soils but are darker. The Santa Lucia soils are dark grayish-brown soils developed on Monterey shale bedrock. In many places the Santa Lucia soils are extremely shallow. The Arnold soils are gray or light gray and rest on parent soft white sandstone. They are of low agricultural value. The Holland soils are brown soils developed on quartz diorite bedrock, and the related Sheridan soils are darker colored but are developed on the same kind of bedrock. Soils of the Felton series are brown or reddish brown and are developed on mica schist bedrock. Most of these soils are shallow and stony.

The soils of the upland coastal-plain areas comprise those of the Moro Cojo and Tierra series. They occupy elevated, eroded, rolling terraces. About 6 percent of the area consists of these soils, which lie just below the upland area. The Moro Cojo soils are sandy, of brown color, and rest on soft sandstone. They erode badly when the native cover of brush and live oak is removed. In general they are of relatively low agricultural value. The Tierra soils are dark grayish brown or dark brownish gray, have very compact clay subsoils, and have a substratum of heavy-textured semiconsolidated materials. Most of the Tierra soils are relatively low in agricultural value.

The soils of the alluvial-fan and stream-bottom areas consist of smooth gently sloping alluvial-fan or flood-plain deposits. They cover about 13 percent of the area surveyed. They are deep, occur in the valleys, and include the soils of the Corralitos, Metz, Soquel, Laguna, Alviso, Pajaro, Botella, and Salinas series. Muck and peat deposits occur in association with the soils of the bottom lands west of Watsonville. The Corralitos soils are light-brown alluvial soils developed from outwash from sedimentary rocks. They are acid in reaction throughout. The Metz soils have light-brown calcareous surface soils and subsoils. The Soquel soils are brownish gray or

dark brownish gray. They are formed from alluvial outwash from sandstone and shale materials. Both the surface soils and the subsoils are acid in reaction. They have a fairly high agricultural value. The Laguna soils are gray. They consist of alluvial-fan outwash from white sandstone. Both the surface soils and the subsoils are acid in reaction, and the soils have a low agricultural value. The Alviso soils are saline soils occurring just above areas of tidal marsh, and they have practically no agricultural value. The Pajaro soils have dark grayish-brown surface soils and mottled subsoils, indicating development under a former condition of poor drainage. Most of them are now well drained and are valuable for a wide range of crops. The Botella soils are dull grayish brown or dull brownish gray and slightly to moderately acid throughout. They have a high agricultural value. The Salinas series includes soils with dull-brown or dark grayish-brown neutral surface soils and calcareous subsoils. They have a high value for the production of lettuce and other crops.

The soils developed on wind-modified coastal-plain materials are members of the Marina and Elkhorn series. A very small area—2 percent of the total area surveyed—borders the coast. These soils are sandy, brown, and acid in reaction. The Marina soils have only slightly compact subsoils, and the Elkhorn soils have subsoils that are moderately compact and somewhat heavier textured than the surface soils. The soils of both series are low in organic matter and comparatively low in available plant nutrients. They are used for growing green peas and winter potatoes. All have been cleared of their native cover.

The soils of the older valley and coastal terraces, members of the Ben Lomond, Pinto, Watsonville, Lockwood, and Montezuma series, represent about 10 percent of the area surveyed. The Ben Lomond soils are inextensive and of little agricultural importance. The soils of the Pinto series occur in fairly large areas on the sloping terraces north and northeast of Watsonville. They have brown or reddish-brown surface soils, and subsoils that are heavier textured and moderately compact. The substratum is yellowish-brown moderately compact gravelly loam or gravelly clay loam. A considerable acreage of these soils is devoted to apricots, strawberries, small fruits, and vegetables. The soils of the Watsonville series occupy fairly large areas on the smooth terraces along the coast and in the Watsonville district. They have heavy claypan subsoils, which limit their agricultural use to shallow-rooted crops. The Lockwood soils occupy smooth sloping terraces along the coastal plain west and northwest of Santa Cruz. They have moderately dense subsoils and are developed on outwash from Monterey shale. The soils of the Ben Lomond, Pinto, Watsonville, and Lockwood series have surface soils and subsoils of moderate to strong acidity. The Lockwood soils are used to a considerable extent for artichokes and brussels sprouts. The members of the Montezuma series have dark-gray heavy-textured surface soils having a neutral reaction, and moderately compact subsoils having a nodular accumulation of lime. They are used for growing grain and grain hay.

Marsh, tidal marsh, coastal beach and dune sand, and riverwash are miscellaneous land types classed as nonagricultural.

The culture of lettuce and Yellow Newtown and Yellow Bellflower apples is of importance in the southern part of the area. Lettuce is grown only in the valleys or in the bottom lands. Apples are grown on a wider variety of soils, although the larger yields are obtained on the soils of the bottom lands. The climate is well suited to lettuce and the yellow varieties of apples. Strawberries and bush berries are important crops and are grown on a wide variety of soils.

Artichokes and brussels sprouts constitute important crops along the coastal-plain terraces northwest of Santa Cruz, on the Watsonville and Lockwood soils. Apricots, plums, prunes, pears, and cherries are grown in certain districts away from the coast. Scattered plantings of wine grapes on the upland soils give light yields. Many varieties of vegetables and field crops are produced, chiefly in small individual plantings. They include peas, tomatoes, potatoes, beans, corn, sugar beets, spinach, onions, garlic, cauliflower, carrots, squash, hay, and grain.

Poultry raising constitutes one of the most important enterprises of the area.

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Office of the Assistant Secretary for Civil Rights
1400 Independence Avenue, SW
Washington, D.C. 20250-9410;

(2) fax: (202) 690-7442; or

(3) email: program.intake@usda.gov.

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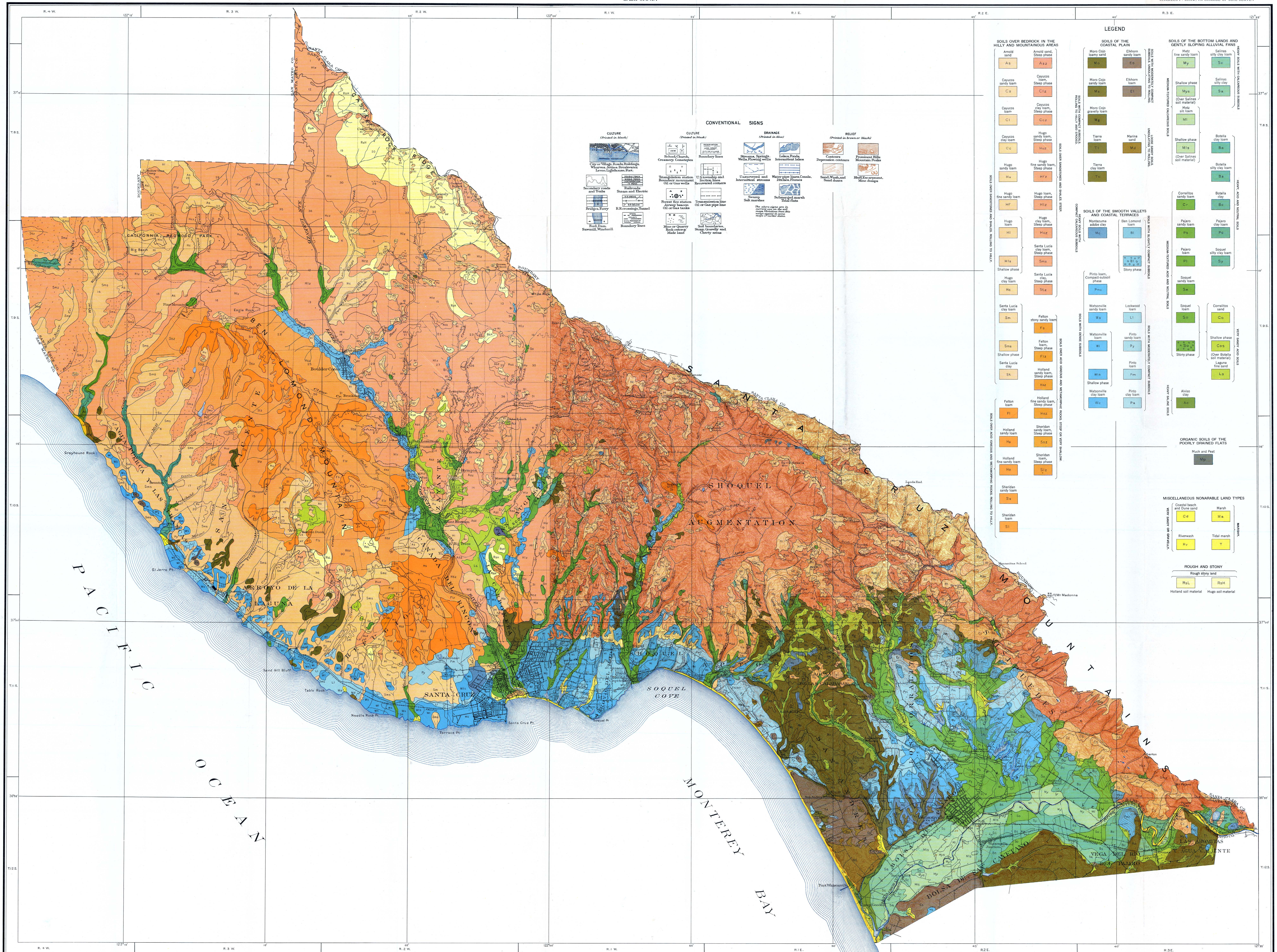
U. S. DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY AND SOILS
HENRY G. KNIGHT, CHIEF
SOIL SURVEY DIVISION, CHARLES E. KELLOGG, CHIEF

SOIL MAP
SANTA CRUZ AREA
CALIFORNIA

UNIVERSITY OF CALIFORNIA
AGRICULTURAL EXPERIMENT STATION
C. B. HUTCHISON, DIRECTOR
CHARLES F. SHAW, IN CHARGE OF SOIL SURVEY



Macy H. Lapham, Inspector, District 5.
Soils surveyed by R. Earl Storie, in charge, Ralph C. Cole, Bruce C. Owen and L. F. Koehler, University of California, and A. C. Anderson, W. J. Leighty and John L. Retzer, U. S. Department of Agriculture.

BASE MAP IN PART FROM
U. S. GEOLOGICAL SURVEY SHEETS

Scale $\frac{1}{62500}$

1 ½ 0 1 2 3 4 Miles

1 ½ 0 1 2 3 4 5 Kilometers

Contour interval 25 feet.
Datum is mean sea level.

LITHO EASTERN OFFSET INC., BALTO

Field Operations
Bureau of Chemistry and Soils
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